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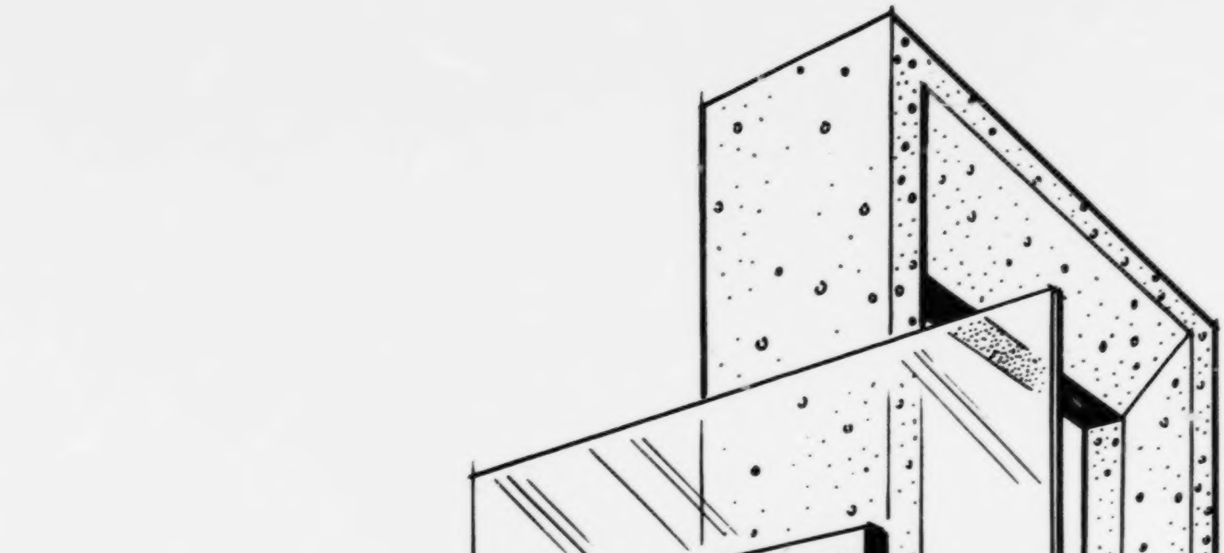
Phenolic Waste Reuse by Diatomite Filtration



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27 *Abstract*

Fiber glass production involves the use of an expensive phenolic resin. A 28 month study was conducted to determine the feasibility of reclaiming waters which had been used for washing resins off of conveyor lines to prevent fouling. The system developed reduces water consumption by utilizing an 8 gpm, 1000 psi spray cleaner. After the conveyors are washed, the water flows through two stages of screening, or primary filtration, and a secondary diatomite filtration unit. Since most of the solids are large, the diatomite filters accomplish the removal of only .6% of the total solids load, with the major removals taking place at the pre-screening equipment. The water re-use system will use the same water 4.5 times before it is completely evaporated, requiring 1 lb of diatomite/500 gallons of water filtered. The system provides water at a net cost of $.37/1000 gallons as compared to $.75/1000 gallons for city water. Substantial operational savings have been realized through conservtion of the expensive phenolic binder. A net "before tax" income return of 9.5% has been obtained on the approximately $165,000 invested. In addition, waste phenolic discharges have dropped 80%, suspended solids have decreased 83%, and dissolved solids have decreased by 50%. In this instance, therefore, waste discharge control has both protected the environment and profited the industry. (Lowry-Texas)

Abstractor Mark V. Lowry
Institution Texas Univ, Austin

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PHENOLIC WASTE REUSE
BY DIATOMITE FILTRATION

Experimental Closed Water System to Eliminate Waste Water Discharge from Johns-Manville's Fiber Glass Insulation Plant #3 at Defiance, Ohio

FEDERAL WATER QUALITY ADMINISTRATION
DEPARTMENT OF INTERIOR

by

Johns-Manville Products Corporation
P. O. Box 159
Manville
New Jersey

Grant WPRD 87-01-68
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September, 1970

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ABSTRACT

The fiberglass industry has long had a problem in disposing of waste water containing phenolic resins. In the fiberglass manufacturing process, airborne glass fibers are sprayed with a phenolic resin as the fiber blanket is formed on the collecting conveyor, causing a deposit of resin to form on the conveyor chain. Prompt cleaning before the deposit sets is needed to permit continuous formation of the glass fiber mat. The waste water originates from the chain washing operation which uses either a caustic wash or high volume showers to remove the resin deposits.

Under the demonstration project a chain cleaning - water reuse system was installed which consists of low volume, high pressure chain cleaning units with water consumption of eight gallons per minute at a thousand psi, two stages of primary filtration to remove large particles and fiber, and a secondary diatomite filter to remove fine particulate matter. The filtered water is suitable for reuse in the binder batch, overspray system, and the chain cleaning units.

The water reuse system has reduced the quantity of water required for chain cleaning, will use water 4-1/2 times before evaporation removes it from the system, requires 1 lb of diatomite per 500 gallons of resin-bearing water filtered and provides water at a net cost of $.37 per 1000 gallons -vs- $.75 for City water.

This report was submitted in fulfillment of a Research and Development Grant 12080 EZF between the Federal Water Quality Administration and the Johns-Manville Products Corporation. Mr. Charles H. Ris III, Project Manager and Mr. William J. Lacy, Chief, Industrial Pollution Control.

Key Words: Fiberglass, phenols, resin, diatomaceous earth filters, water reuse, operating cost.

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I

CONCLUSIONS

Conclusions from this twenty-eight month project to reclaim industrial waste water, are as follows:

(1), Elimination of the "chain" cleaning process waste has been achieved by reuse of the "chain" cleaning water to provide the water source for process needs.

(2) A check of pollutants discharged in July 1969 to Preston Run shows that phenolic discharges have been cut to one-fifth, suspended solids to one-sixth, and dissolved solids to one-half of the December 1968 loading prior to the start of closed-system operation.

(3) Pollution in Preston Run tributary has been reduced but not eliminated. Elimination will be accomplished when certain streams not in the scope of this project are routed to the City of Defiance treatment plant early in 1970.

(4) Conservation of an expensive resin used as a binder material through water reuse has contributed substantial operating savings.

(5) Conservation of city water purchases through reuse has been appreciable in water and dollars saved.

(6) Net "before tax" income returns 9.5% on the investment.

(7) Foaming is an operational hazard which results when high pH ranges occur.

(8) Fungus growths in the circulating water require some degree of treatment to prevent flow stoppage in pipe lines.

(9) pH control of ammonia content is necessary to successful filtering of the "chain" cleaning water.

(10) Dissolved solids up to 6000 parts per million have successfully been handled in the circulating system.

(11) Water is reused 4.5 times before evaporation removes it from the closed system.

(12) Approximately .6% of the solids removal is accomplished by the diatomite filters, the major removal being accomplished by pre-screening equipment.

(13) Approximately 500 gallons of resin-bearing process water were filtered per pound of diatomite.

(14) A filter aid (used) to dirt (collected) ratio of three to one was typical of the diatomite filtering operation.

(15) The gross cost of filtered water in this process is estimated at approximately $1.59 per 1000 gallons, of which $.53 is capital cost and $1.06 is operating cost. The net cost of filtered water is $.37 per 1000 gallons, derived by crediting the system savings against the $1.59 gross cost.

(16) Similar water reuse systems will be proposed at all Johns-Manville plants where a phenolic resin discharge occurs. Johns-Manville has a total of nine (9) such plants.

II

INTRODUCTION

Fiber Glass Production.

For years, the fiber glass manufacturing industry has had a problem of disposal of wastewater containing phenolic resin, which is used as a binder in the manufacture of glass fiber insulation products. In a typical plant, fiberized glass is formed via an air stream which deposits the fiber onto a moving open mesh collecting conveyor - commonly called the "chain". Referring to Fig. I, a water solution of phenolic resin is sprayed on the glass fiber as it is formed. The resulting mat is then transferred from the collecting conveyor to an oven where the binder system is continuously dried and cured, after which the mat is cut to size and packaged.

The resin spraying operation results in resin deposition on the collecting conveyor "chain" and unless this deposit is removed, the conveyor becomes fouled and inoperable. Caustic soda baths (method 1) or water sprays (method 2) are used to clean the chain. It is this "chain" wash water which dissolves the phenolic resin, carries it out to streams, and is the source of phenolic pollutants from a fiber glass plant.

Chain Cleaning Process.

Johns-Manville Fiber Glass Insulation plants have found it necessary to clean the wire mesh conveyor upon which the fiber glass mat is formed in order to maintain free passage of air through the conveyor mesh (refer to Figure I). During the formation of a mat or felt blanket, free freshly formed glass fibers - spray coated with a phenolic resin binder and cooled with "overspray" water to control rate of resin cure - are air borne to the forming conveyor through which the air passes, leaving the fibers piled in a uniformly thick felted blanket across the width of the conveyor. The air stream which transports the glass fibers to the conveyor also contains droplets of resinous binder which have not adhered to the glass fibers. Many of these droplets deposit resin on the wire mesh conveyor chain, and if not removed, the resin build-up will eventually restrict passage of the air stream. When the deposit becomes sufficiently great, blanket formation is no longer possible, necessitating replacement of the conveyor with a new or renovated conveyor wire - frequently referred to as "chain". "Chain" has historically been cleaned while in service to extend its useful operating period before becoming "blinded" with resin deposits by routing the "chain" through a shallow pan containing a hot caustic water solution. Fresh water makeup to the pans created caustic overflow to the sewers containing phenolic resin and glass fiber.

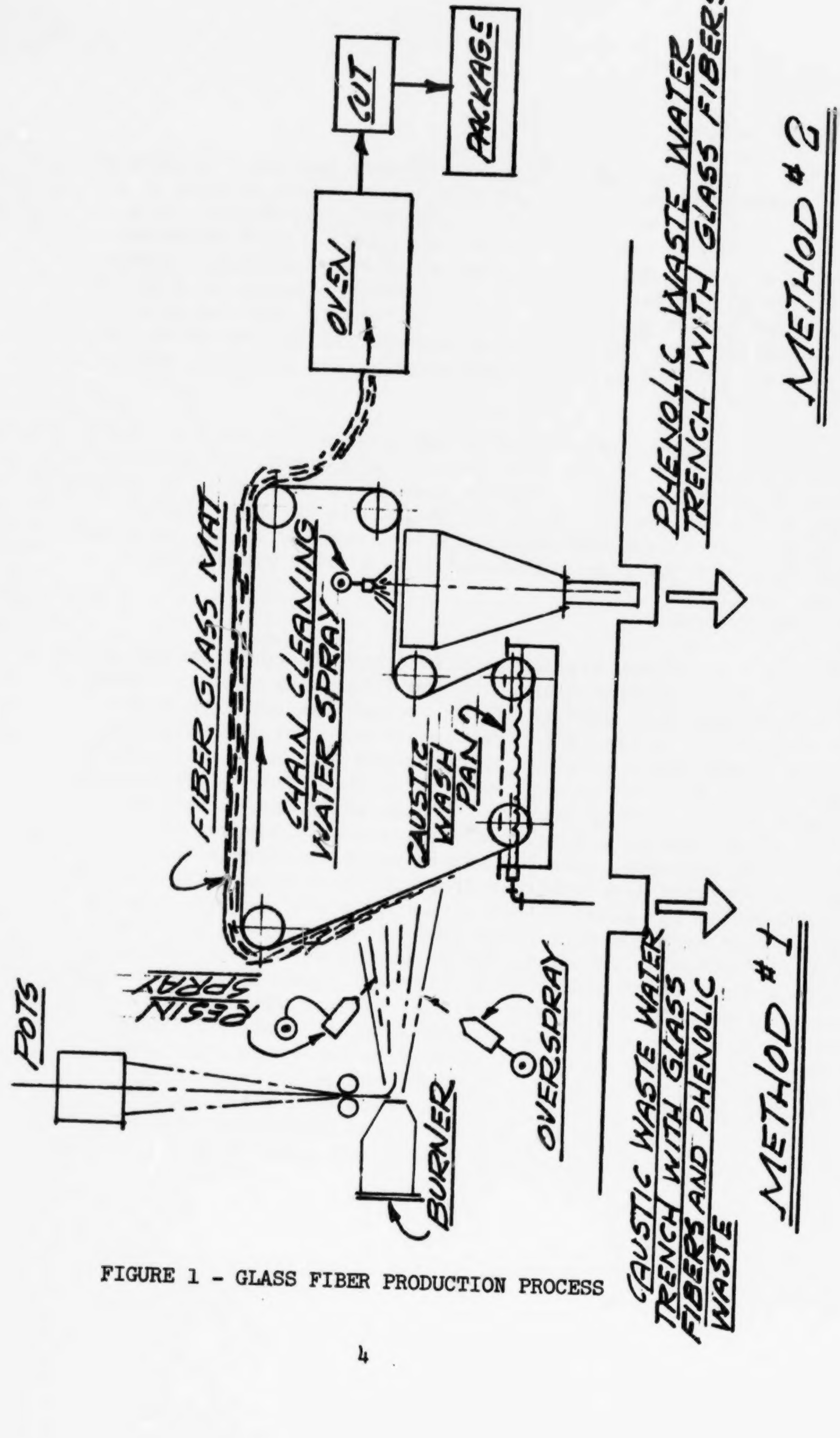
POTS
RESIN SPRAY
BURNER
OVERSPRAY
FIBER GLASS MAT
CHAIN CLEANING WATER SPRAY
CAUSTIC WASH PAN
OVEN
CUT
PACKAGE
CAUSTIC WASTE WATER TRENCH WITH GLASS FIBERS AND PHENOLIC WASTE
PHENOLIC WASTE WATER TRENCH WITH GLASS FIBERS
METHOD # 1
METHOD # 2

FIGURE 1 - GLASS FIBER PRODUCTION PROCESS

Subsequently, a recirculating method of "chain" cleaning used 300 psi water jets spaced 3" apart across the conveyor width. This method, not employed at Plant #3, sought to reduce the discharge through re-use of the water after sedimentation in a clarification tank. Unfortunately, the clarification was inadequate, resulting in frequent plugging of nozzles. Also, the small amount of fresh water needed to make up for evaporation and other losses was insufficient to purge the recirculated water of dissolved solids which built up to the degree that it was necessary to purge the system on a periodic basis by dumping the water, with resulting loss of phenolic bearing water to the environment.

III

FWQA DEMONSTRATION PROJECT

Title:	Phenolic Waste Reuse by Diatomite Filtration
Period:	**September 1, 1967 to February 1, 1970**
Funds:	Estimated Cost $164,700 - Federal Grant 50% up to $82,350

Purpose.

This project is designed to demonstrate the effectiveness of a total process water reuse system involving diatomite filtration to treat phenolic bearing waste waters prior to reuse. The chain wash water contains glass fiber and caustic, in addition to the phenol content. The objective of this project is to eliminate completely the discharge of phenolic bearing "chain" wash water from Johns-Manville Plant 003 at Defiance, Ohio.

Other components of the total waste stream such as domestic waste, caustic mandrel cleaning solutions, boiler blow-down and softener backwash, are to be ponded, aerated and chemically treated before release to the stream, pending ultimate disposition in separate treatment facility or connection to municipal treatment plant.

Scope.

The project includes several phases.

Design: - Equipment selection and location were the primary elements involved here. A knowledge of the quantities of water, phenol and other contaminants was also needed to size equipment.

Pre-construction Studies: - To establish the success of the project, it would be necessary to know the conditions prevailing prior to operation of the project. Weirs were established which would measure the discharge to the stream before operation of the project. Samples and analysis of the discharge would establish the quality of the discharge, which in conjunction with the flow, would provide the means to determine quantities of contaminating factors in the discharge, thereby furnishing a baseline for future reference. Water meters would also be installed to establish city water use at significant points in the operation.

Procurement: - Purchase of equipment and selection of installation contractor through normal channels of competitive bidding would be a necessary phase of activity prior to construction.

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Construction & Installation of Equipment: - Revisions to existing product units, construction of floor trenches and pits, piping, wiring, installation and painting of all equipment would be final phases of the activity before operation.

Operation: - The operational phase in the scope of the project would be the most important, for failure of the equipment to function reliably could cast doubt on performance reported. If reliability in this phase was good, uniformity in operating conditions would, in turn, establish dependable data.

Post Construction Studies: - Collection of data on the same basis as that set up in the Pre-Construction studies would make measurements possible which could be compared with the pre-construction studies to determine project effectiveness.

Evaluation: - Analysis of the measured data collected during pre- and post-construction studies would be a continuing part of the operating phase covered in monthly reports, to be summed up in a final report after project completion. Collected data would provide information on suspended and dissolved solids, phenolic content, pH at significant points in the recirculation loop and at the point of discharge to the stream. Consumption of water, ammonia, diatomite and maintenance materials would also be accounted in the evaluation.

Treatment Theory.

The project proposed to clean the "chain" and eliminate discharge of the "chain" cleaning process waste. (Refer to FIGURE 2 - Closed Water System). The principle employed here is to re-circulate the "chain" cleaning water - but to improve it continuously; first through diatomaceous earth filtration and secondly by purging of dissolved solids through use of "chain" cleaning water as the source of water for binder mixing and overspray water. The diatomaceous filtration improves the reliability by elimination of nozzle plugging.

As noted previously, the formation of the glass fiber felt on the "chain" is accomplished through spray addition of a phenolic resin - water mixture, known as "binder". To control the curing rate of the binder, water known as "overspray" is sprayed into the forming process. Both "overspray" and the water in the "binder" are subsequently evaporated in the oven curing process which follows the forming step. Therefore, the use of "chain" cleaning water for "overspray" and "binder" mixture provides the means for purging the "chain" cleaning water of high concentrations of dissolved solids, since the water evaporated in the oven is "made-up" into the "chain" cleaning supply.

The water containing the phenols can be used up within the process if it is recycled and filtered satisfactorily. The system as proposed will contain about 5,000 gallons within itself at any one time and has a cycling or use figure of about 4,500 gallons/hour on an average. The

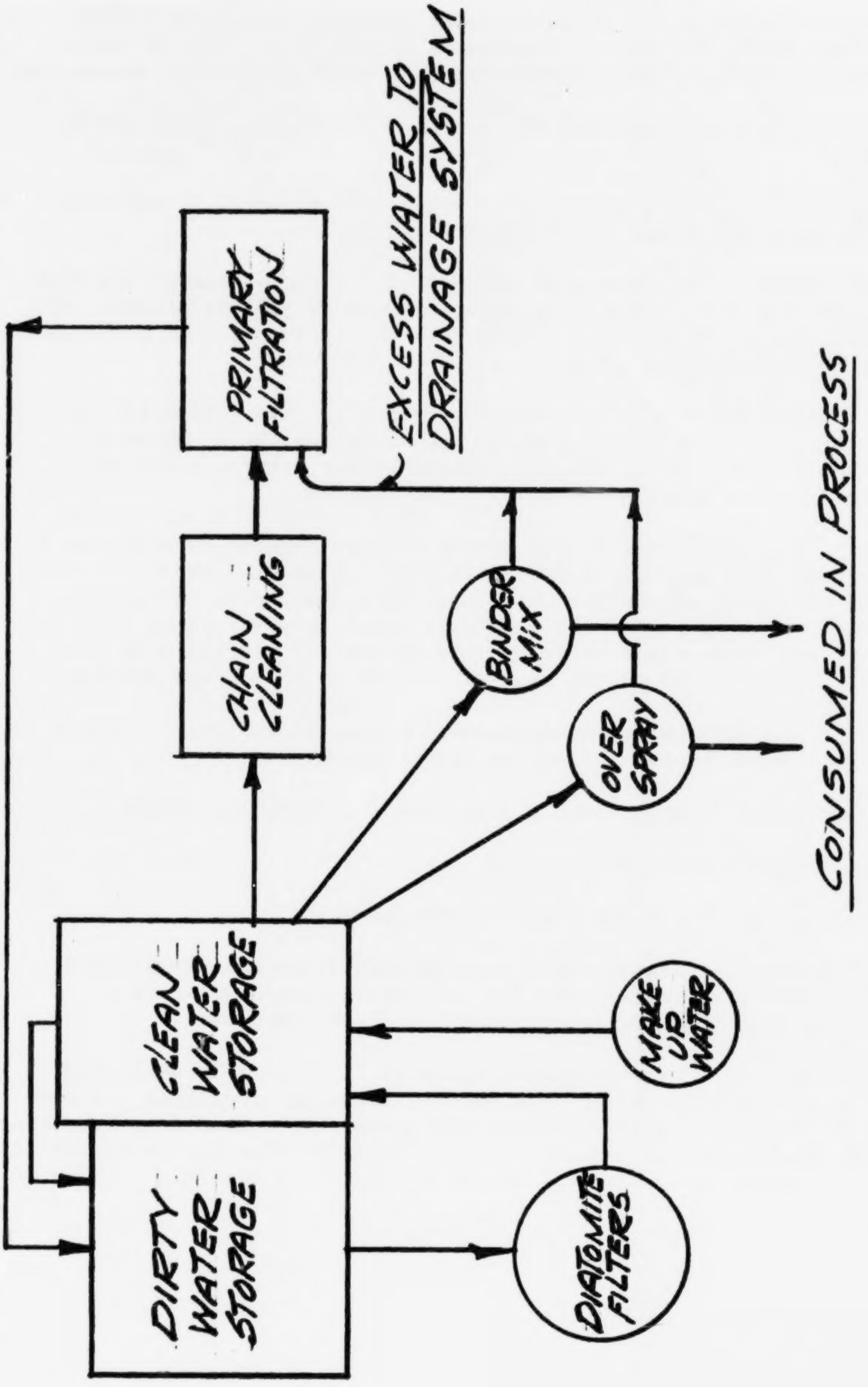
DIRTY WATER STORAGE
CLEAN WATER STORAGE
DIATOMITE FILTERS
MAKE UP WATER
CHAIN CLEANING
PRIMARY FILTRATION
BINDER MIX
OVER SPRAY
EXCESS WATER TO DRAINAGE SYSTEM
CONSUMED IN PROCESS

FIGURE 2 - CLOSED WATER SYSTEM

volume recirculated is sufficiently small that the normal fresh water make-up (due to drying losses) represents a continuous purge of about 50% of the circulated flow - making periodic dumping of water unnecessary.

The phenol-containing water can be used in three areas. These are as follows:

1. Chain Cleaning - This water use would amount to about 50 gallons/minute when all machines are operating.

2. Binder Mixing (and subsequent evaporation) - The estimated use when all machines are operating is approximately 15 gallons/minute. A minimal amount of water is returned to the system of that which is used up in binder spraying.

3. Overspray Water (and subsequent evaporation) - The estimated use of overspray water is the same as the binder water, or about 15 gallons/minute. As in the case of the binder sprays, a minimal amount of this water is returned to the system.

In summary, the completely closed system will be capable of using up approximately 1800 gallons of water per hour. This will amount to a replacement of almost 40% of the water that is operating in the system in an hour, on an average. (It should be noted, however, that variations in product and binders and various means of operation could drop this amount to as low as 20% of the over-all volume in this sytem per hour).

In order to use this water, as delineated above, it must have certain properties. These properties are as listed below:

1. Maximum Solids (larger than 0.5 microns) - 0.0002% by weight.

2. pH - Must be between 8.5 and 9.5.

3. Phenol Content - Not important in our operation.

4. Make-up Water - Make-up water must be soft water and J-M treated city water is satisfactory. Our goal for softened water is a water of less than 50 parts per million (ppm) hardness.

The treatment of the caustic water, which is in relatively small quantities as it is only dump water from mandrel cleaning operations, is best handled by dumping to a holding pond and treating the pond at prescribed intervals as required in order to release it to Preston Run or return it for plant process use. Neutralization with hydrochloric acid is planned.

Equipment For Water Reuse System

The equipment needed to accomplish our water treatment is shown on FWQA approved drawings in detail. The major items, however, are noted below:

Three (3)	1000 psi chain cleaning pumps
Five (5)	Chain cleaning spray systems
One (1)	Scrap pump dewaterer
Two (2)	Dirty water sump pumps
Two (2)	Primary filters
One (1)	2,000 gallon dirty water tank
Two (2)	Per Model 450-4-36 SAFS Diatomite type filters
One (1)	2,000 gallon clean water tank
Four (4)	Filter water transfer pumps (2 primary filtrate and 2 secondary filtrate)
Four (4)	Polishing (cartridge type) filters
Two (2)	Overspray pumps

Material Savings.

Conservation in the use of certain materials is expected as noted below:

"Chain" cleaning water previously discharged contained phenolic resin washed from the chain. By recycling the "chain" cleaning water the phenolic resin content (soluble portion only) can be recovered, thereby reducing the quantity of fresh resin required to prepare "binder" mixture. A valuable resource can thereby be conserved and an appreciable dollar saving expected.

Elimination of the need for caustic cleaner for "chain" cleaning is an expected economy.

The re-use of water infers that savings in water consumption are expected. A feature of this project is the use of low volume showers at 1000 psi to accomplish the "chain" cleaning effectively; to hold the circulating water volume low so that the percentage of make-up water would be high and to minimize the investment in filtering equipment. Economy in the use of water can be achieved through the use of rotating nozzles which effectively extend the water jet over a large area of chain.

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IV

DESIGN AND INSTALLATION OF FACILITIES

Effluent Standards.

The objective of the project is to eliminate discharge of process effluent. Any discharge, however, should comply with the Water Pollution Control Codes of the State of Ohio, which, under Stream Standards for Potable Water are:

Dissolved Oxygen.
The dissolved oxygen content shall be 5 ppm.

Phenol.
The phenol content shall not exceed 1 part per billion.

pH.
The pH shall have a value between 6.5 and 8.5.

Bacteria, Coliform Group (B. Coli)
Not to exceed 5000 organisms per 100 ML.

Dissolved Solids.
Dissolved solids shall not exceed 500 ppm.

Tastes & Odors.
The water shall be free of objectionable odor and taste. Odor shall not exceed the threshold number of 24 at 60 deg. C.

Temperature.
Not to exceed 93 deg. F during May through November or 73 deg. F during December through April.

Aesthetic Consideration.
Discharged water must be:

(a) Free from solids that will settle to form putrescent or otherwise objectionable sludge deposits.

(b) Free from floating debris, oil, scum and other floating materials in amounts sufficient to be unsightly or deleterious.

(c) Free from materials producing color, odor or other conditions in such degree as to create a nuisance.

(d) Free from substances toxic or harmful to human, animal or aquatic life.

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Design Criteria and Equipment Description.

Each significant equipment item is described, and its function delineated below:

Changes to Existing Facilities:

Product Units:

Design Criteria.
Remove dissolved and suspended solids from conveyor chain. Rotating jet - 540'/min, fan 6" wide - maximum supply pressure 1000 psi. Capacity to provide 100% cleaning coverage at conveyor speeds up to 57'/min. Sluicing velocity in trench to be a minimum of 8'/min. At each product unit a cleaning station has been built into the structure through relocation of forming conveyor chain travel. Figure #3 and Figure #10 depict a side elevation view of the "chain" cleaning station. After discharge of the fiber glass blanket from the forming conveyor, the chain returns beneath its upper travel and "upside down". This situation permits the rotating nozzle to wash off in a reverse direction phenolic resin binder and small adherent clumps of fiber glass. The rotating nozzle turning at 115 revolutions per minute at a radius of 18 inches, uses 8 gallons per minute of 1000 pound per square inch water to effectively clean a three foot width of conveyor chain. Four product units have 3' nominal conveyor width and are cleaned with one nozzle, the fifth unit having a 6' nominal chain width is cleaned with two nozzles.

The wash water blows downward through the chain into a hopper which guides the water into a "U" shaped trench in the floor. The half-round trench bottom was adopted to obtain maximum sluicing effect from the relatively small quantity of cleaning water employed. Accumulations of fiber occur on the sloped sides of the hopper, which, in due course, fall into the trench. Frequently the 10" diameter trench becomes obstructed with these clumps of wet fiber, but the accumulating water upstream eventually floats the obstructing dam away.

The trench passes in a straight run beneath all five production units collecting water from each "chain" cleaning station. It is pitched to discharge into the scrap collection pit. Despite frequent obstructions of fiber in the trench, it has seldom been blocked to the point that manual attention is required to maintain flow.

New Construction.

Scrap Collection Pit.
The scrap collection pit houses below floor level a reciprocating scrap pump, which is functionally a screening device that extrudes screened fiber solids in a damp cylindrical shape to a waste bucket, and two different types of pumps for transferring the screened "chain" wash

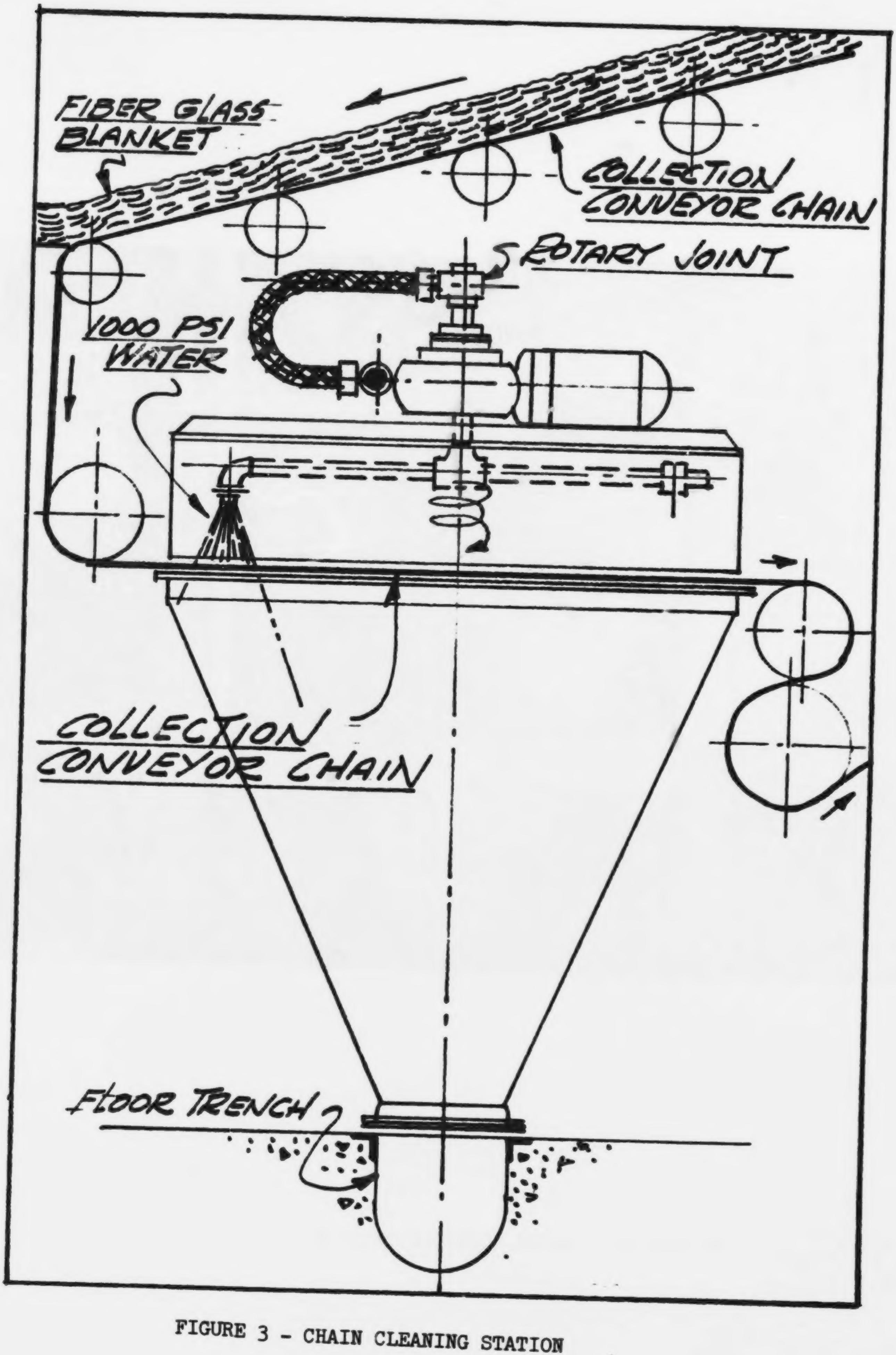
FIBER GLASS BLANKET
COLLECTION CONVEYOR CHAIN
ROTARY JOINT
1000 PSI WATER
COLLECTION CONVEYOR CHAIN
FLOOR TRENCH

FIGURE 3 - CHAIN CLEANING STATION

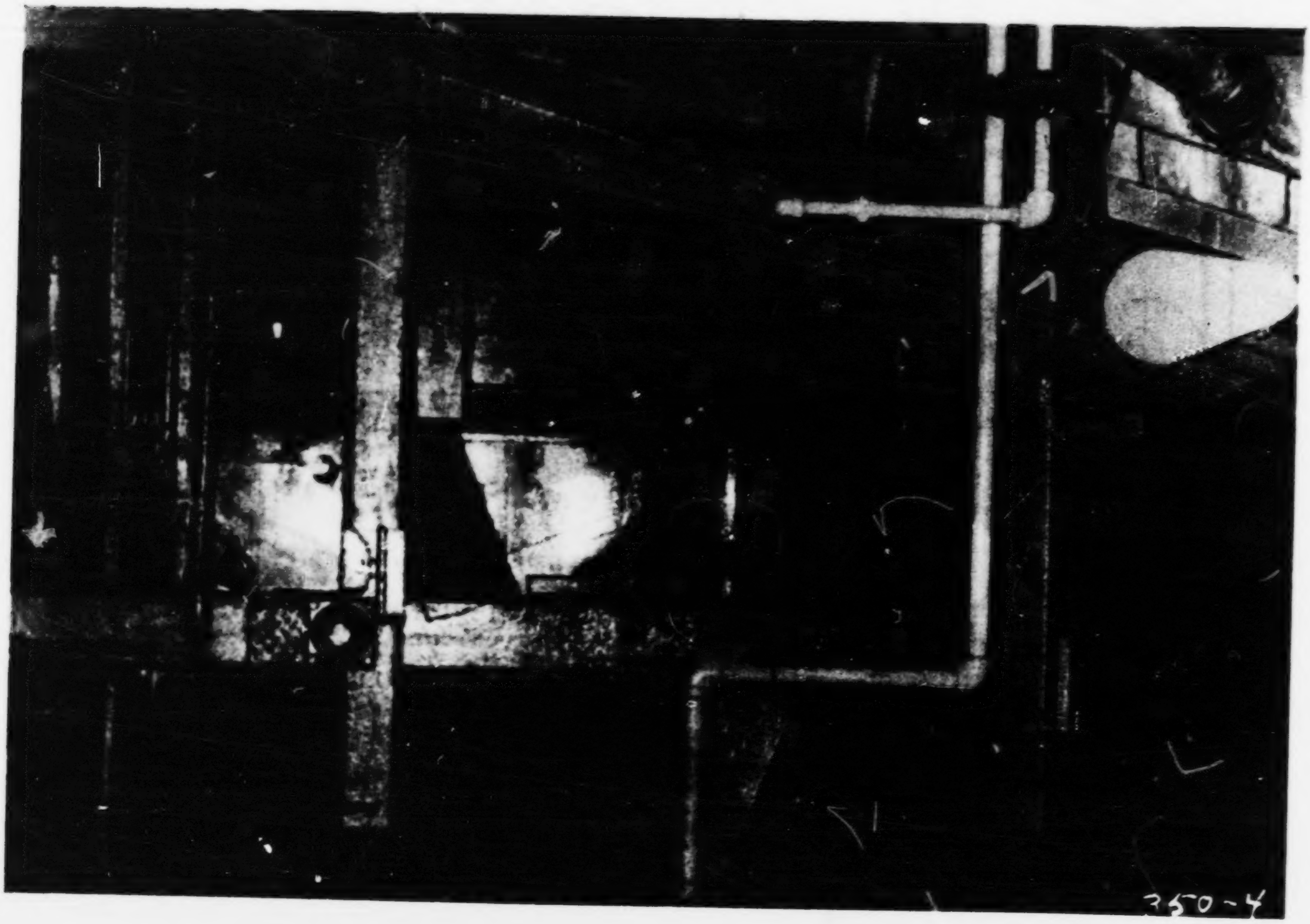

FIGURE 10 - CHAIN CLEANING STATION

water to the primary filters. A sump pump is also included which will pump out the pit in the event of failure of any equipment in the scrap collection pit. Equipment is so arranged that a vibrating screen could replace the scrap pump.

Essentially, the collection pit is a screening and pumping laboratory where various means of pumping the fiber bearing "chain" cleaning water could be tried to determine optimum handling methods.

Reciprocating Scrap Pump (Screen-extruder).

Design Criteria:
Pass up to 100 GPM of water containing glass fiber. Screen and dewater solids retained on 3/32" diameter punched screening plate.

As noted above, this specially designed piece of equipment functions to screen bulk fiber out of the trench water and discharge the fiber in a damp cylindrical extrusion. Figure #9 shows the discharge end of the pump with fiber being extruded in an 8" diameter cylindrical shape. Water and fiber enter the horizontal single-acting, single-cylinder pump at the level of the trench flow line through the side of an open top hopper which is mounted on top of the cylinder. When the plunger retracts the trench water drops into the cylinder and thence through the 3/32" diameter holes in the perforated cylinder wall. The coarse clumps of fiber remain in the cylinder bore and are pushed out the open end of the cylinder through a forming tube when the plunger advances. Fiber solids are thus screened and dewatered in this special "scrap" pump, which actually does not pump, but gets its name from its reciprocating plunger type of construction. Screened water containing short abrasive glass fibers is collected in a pan beneath the scrap pump and routed to either of two centrifugal pumps.

The scrap pump is quite an effective instrument for removing bulk fiber from the water. It is, however, an added piece of equipment that may be eliminated if there is added capacity elsewhere to remove fiber. To determine whether it could be eliminated, provision was made to extend the floor trench through the feed hopper directly to the centrifugal pumps, thereby by-passing the scrap pump.

Centrifugal Pumps to Primary Filters.

Design Criteria:
Pump 100 GPM @ 40' TDH of water containing up to .2% of glass fiber ranging in size from 100 mesh up to clumps 6" in diameter. Pump impellers and casing to be rubber covered to resist abrasion.

The collection pit contains two types of pumps - one a wet well and the other a dry well pump. It was believed that under proper installation conditions both types could satisfactorily handle the fiber bearing "chain" cleaning water without interruption due to plugged pump intakes. After study, it was reasoned that the most effective way to bring the

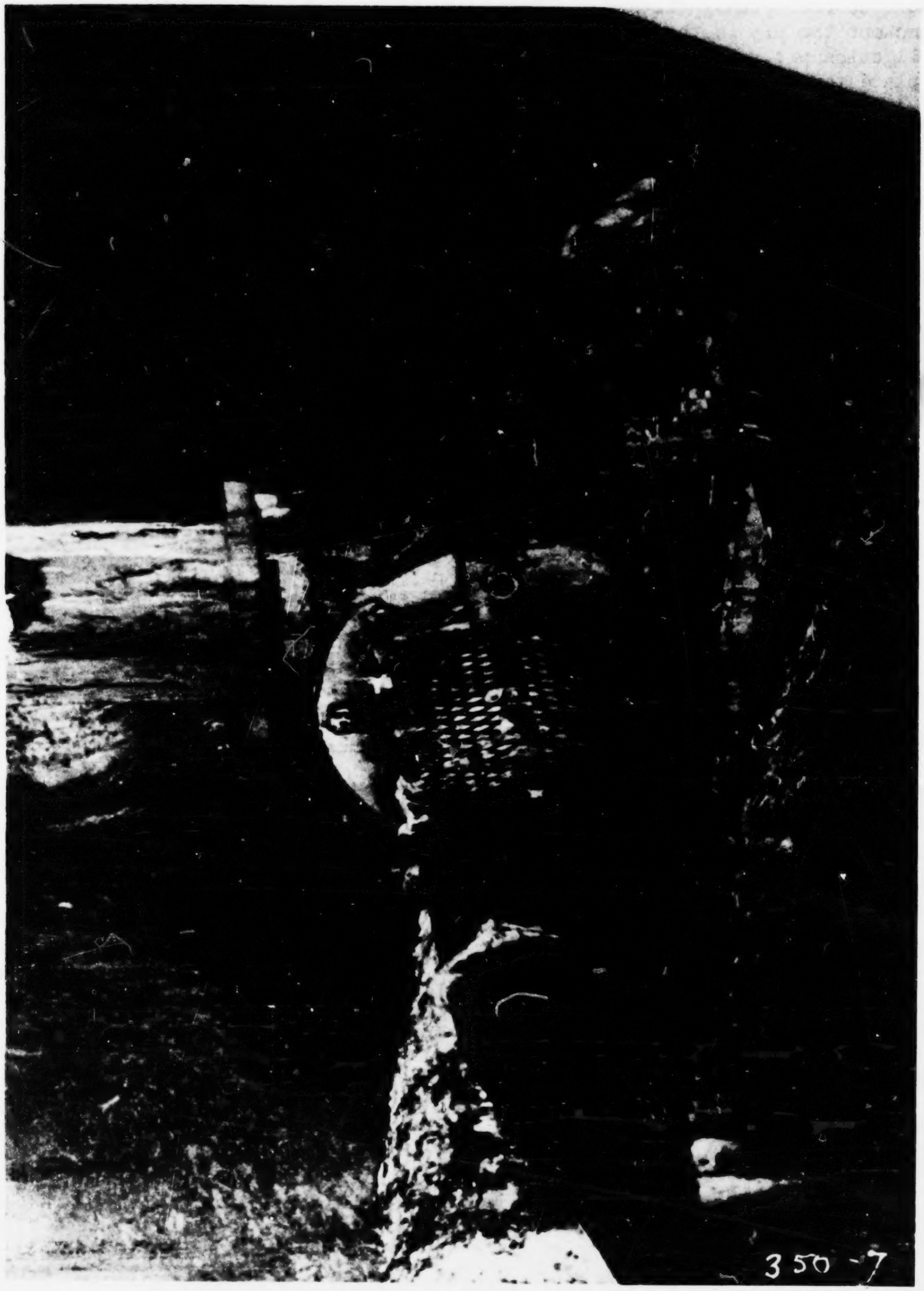

FIGURE 9 - SCRAP PUMP

fibrous solids to the pump intake was through use of a conical sump. Special conical sumps were accordingly incorporated into the setting of both wet and dry well pumps.

Dry Well Pump.

Figure #4 shows the conical sump used in the "dry well" installation. This rubber lined centrifugal pump has a capacity of 100 gallons/minute at 40' total dynamic head. It does not require seal water at the shaft packing due to special impeller construction which creates suction at the packing box to minimize shaft wear from abrasive liquids. When handling screened water from the scrap pump it has operated very reliably for much of the twelve month operating period. When handling unscreened water direct from the trench, and by-passing the scrap pump on a two day trial, this dry well "pump-sump" combination performed satisfactorily with the aid of a 200 pound/square inch jet of water from a 1/4" pipe lance clamped to the inside of the cone and terminating at the bottom of cone. The jet served to break up large clumps of fiber which otherwise would have plugged the 4" diameter intake. This trial was made to predict operation of dry well pumps at a new Fiber Glass Insulation plant at Winder, Georgia.

The experiment established the fact that pumping of "chain" cleaning water with fiber included is feasible without pre-screening equipment when a jet assisted conical convergent approach to the pump intake is used. Subsequent experience at the Winder Plant has verified the experimental finding.

Wet Well Pump.

Consideration of alternate methods of pumping "chain" cleaning water bearing glass fibers indicated that a rubber coated wet well pump having no submerged bearings or packing glands would offer the simplest and most reliable pumping equipment. To handle suspended glass fibers it was reasoned that a conical sump which would guide all liquid and fiber directly to the impeller intake represented the ideal approach condition. Previous experience with a sump pump in a typical rectangular sump had demonstrated that the glass fiber would settle out in the sump areas not immediately adjacent to the pump. This situation required manual attention to remove the deposited fiber. Accordingly, the development of a conical sump became an early requirement for successful pumping of the "chain" cleaning water. FIGURE 5 shows the setting used for a wet-well installation. Space limitations prevented use of a true cone. A modified cone bottomed sump was employed with a cylindrical sloping trough carrying the water into the apex of the cone from which point it could only rise into the eye of the impeller. The pump used had a capacity rating of 100 gallons/minute at 40' total dynamic head to duplicate that of the dry well pump. It had no submerged bearings or packing box, strainers were removed and the liquid contacting parts were rubber covered to resist abrasion.

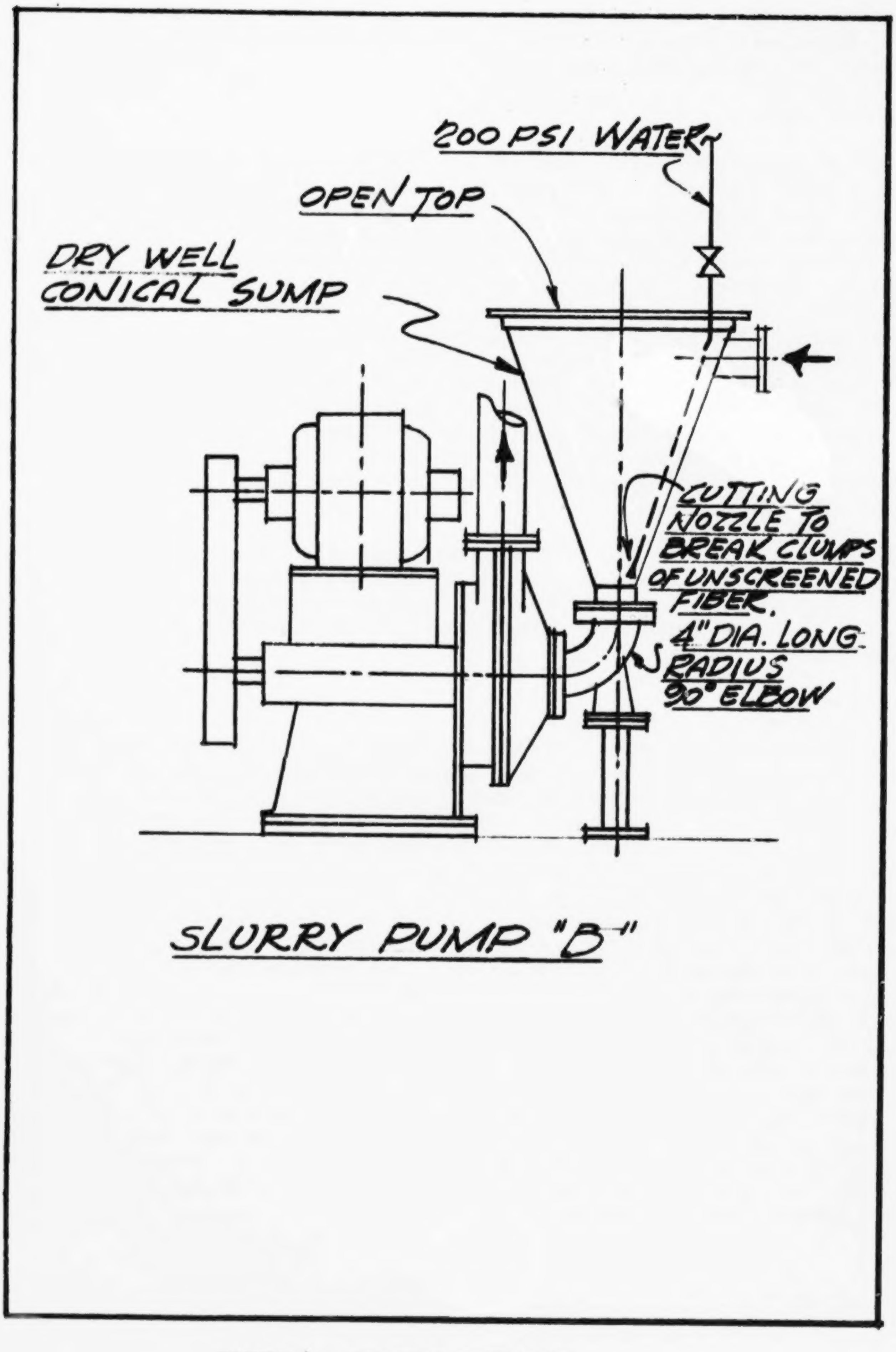
200 PSI WATER
OPEN TOP
DRY WELL CONICAL SUMP
CUTTING NOZZLE TO BREAK CLUMPS OF UNSCREENED FIBER.
4" DIA. LONG RADIUS 90° ELBOW
SLURRY PUMP "B"

FIGURE 4 - DRY WELL PUMP SUMP

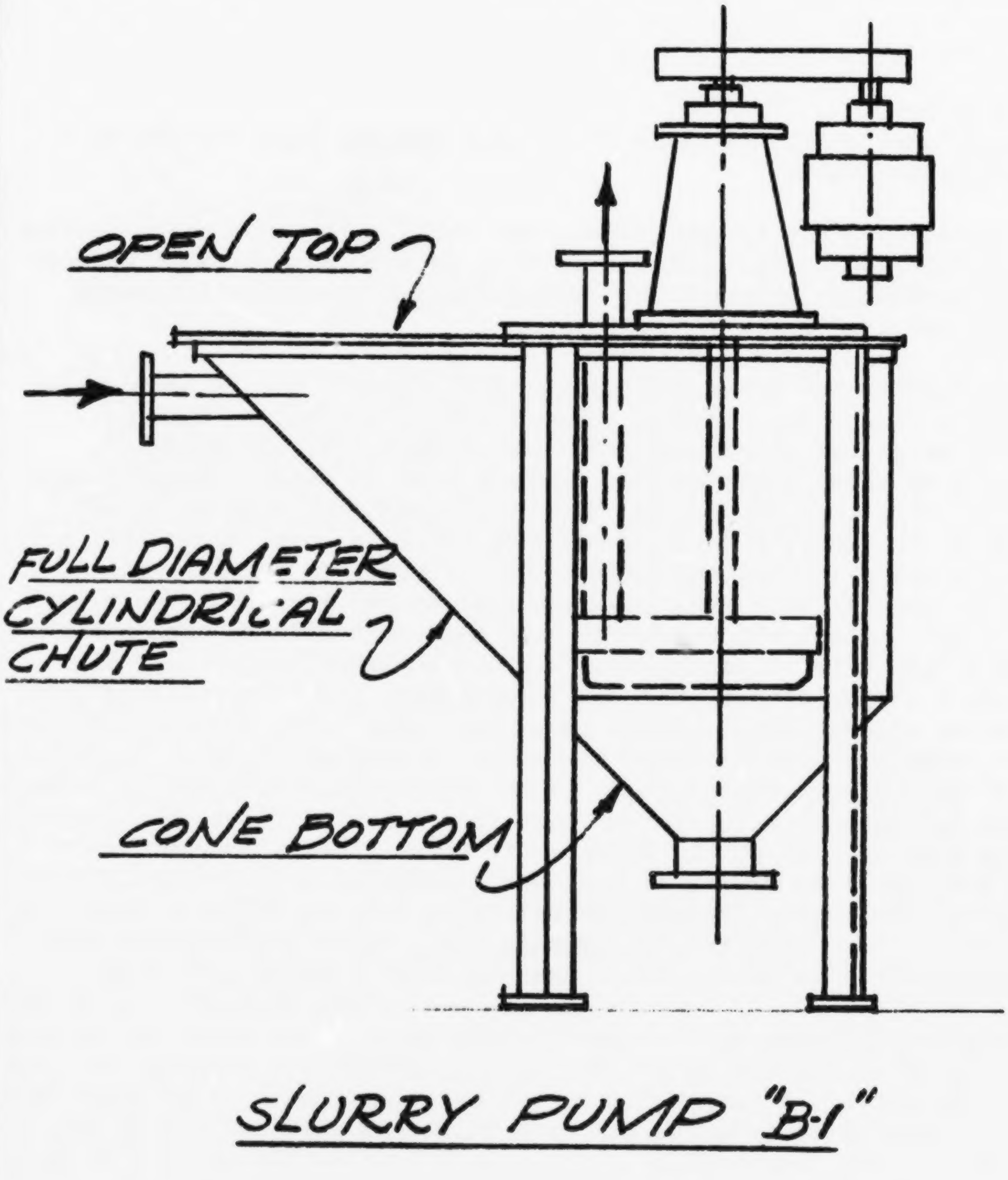
OPEN TOP
FULL DIAMETER CYLINDRICAL CHUTE
CONE BOTTOM
SLURRY PUMP "B-1"

FIGURE 5 - WET WELL PUMP SUMP

When supplied with screened water from the scrap pump this pump performed adequately for the first four months of the operating period, although the sloping chute had to be cleaned daily of fiber deposits. This unit adequately demonstrated ability to handle screened "chain" cleaning water. No attempt was made to try its capabilities on unscreened water. It is believed however, that with a true conical sump and aided by a water jet to break up large clumps of fiber, the wet well pump would handle unscreened "chain" cleaning water.

Primary Filters.

Design Criteria:
Remove suspended solids retained on 60 mesh screen; Pass 120 GPM water containing glass fiber.

"Chain" cleaning water is pumped from the scrap collection pit by either of two slurry pumps. The water drops into an open hopper which spreads the water horizontally upon a horizontal 80 mesh polypropylene media belt about 30" wide.

FIGURE #6 illustrates the operation of this filter. The filtered water falls through the media, leaving glass fiber on the belt. When a sufficient weight of fiber and water has accumulated, the weighted media is moved ahead by frictional contact with an underlying grid type of conveyor belt. As the weight is carried away, friction no longer moves the media, which remains stationary until the next accumulation occurs. Figure #11 shows two primary filter units in service with the right hand unit receiving the dust load of saw kerf from the pipe covering dust collectors, while the left hand unit filters the "chain" cleaning water. The collected fiber is "back washed" from the media with a small shower of diatomite filtered water, the fiber falling into a box having a screened bottom to permit drainage. The accumulated fiber is forked away manually and sent to dry waste disposal areas. Mechanization of this aspect would reduce labor costs. The liquid falls through the media into a collecting pan or tank from which it flows to a centrifugal pump for transfer to the dirty water tank. The purpose of the primary filters is to remove as much solid material as possible to make the remaining secondary (diatomite) filtering duty as light as possible. The primary filters have handled average loads satisfactorily but have tended to overflow at peak loads - thereby passing extra dirt load to the secondary filters. Polypropylene cloth has been changed from 60 mesh to 100 mesh to increase solids removal. 80 mesh is currently in use since the 80 mesh is of heavier gauge material and has longer wearing life than the 100 mesh media. A larger filter having approximately four times the capacity of the existing units has been built and will shortly be put into service. The increased capacity should improve the cycle life on the diatomite filters and possibly permit elimination of the scrap pump by accepting all the screening duty on the new primary filter.

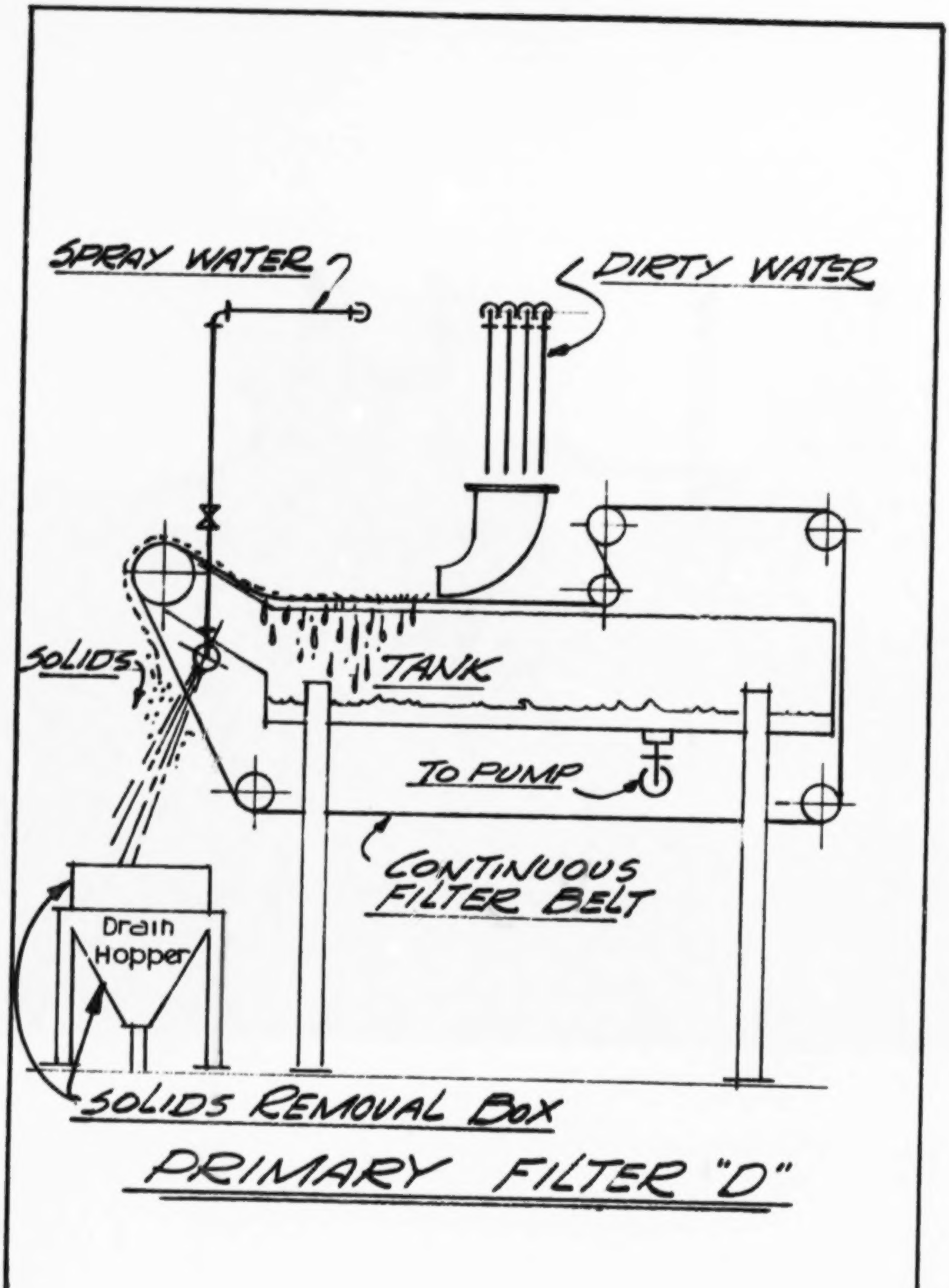
SPRAY WATER
DIRTY WATER
SOLIDS
TANK
TO PUMP
CONTINUOUS FILTER BELT
Drain Hopper
SOLIDS REMOVAL BOX
PRIMARY FILTER "D"

FIGURE 6 - PRIMARY FILTER

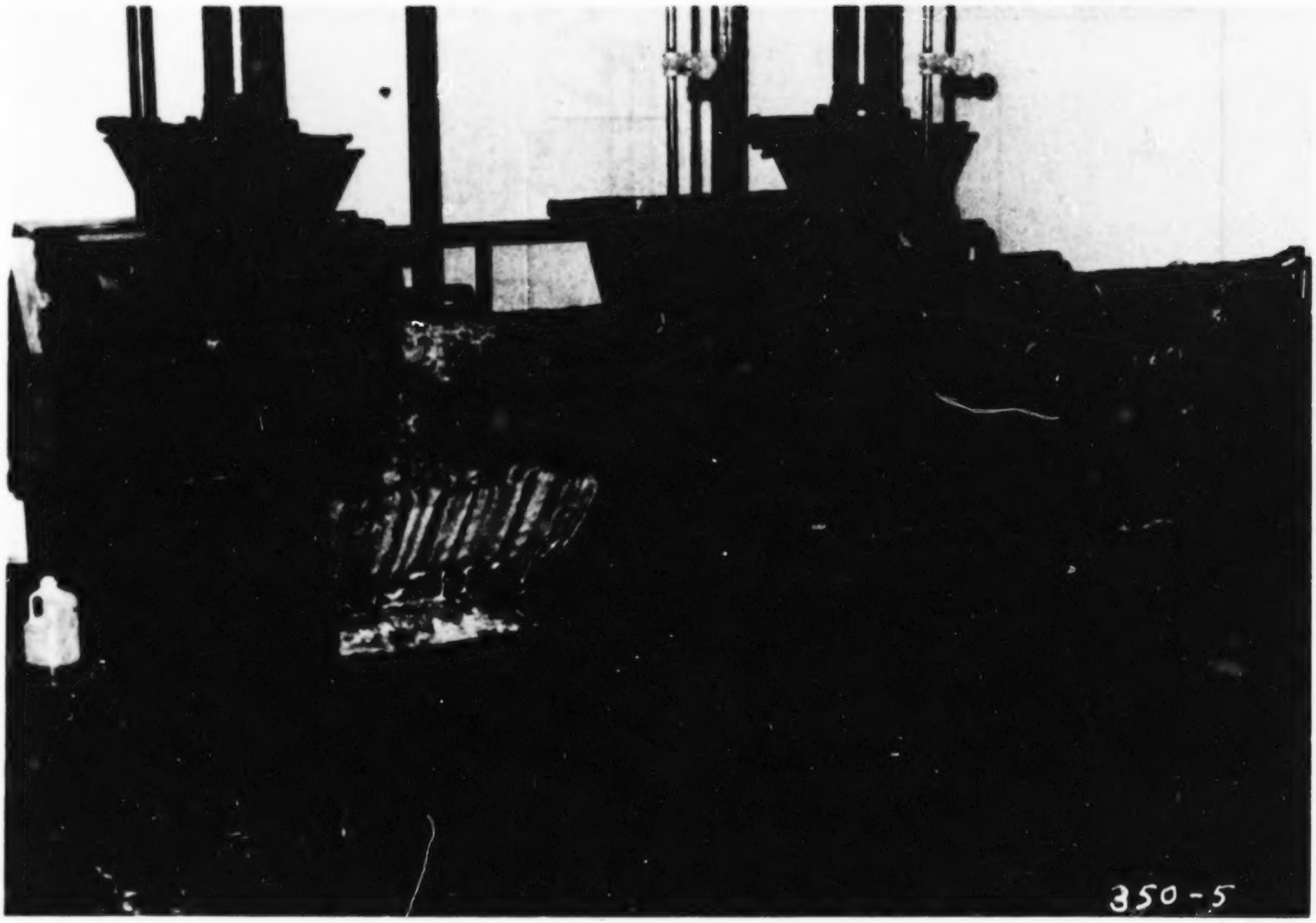

FIGURE 11 - PRIMARY FILTERS

Secondary Filters.

Design Criteria:
A complete package unit consisting of dual filter units to automatically filter phenolic bearing water at flow rates of 8 - 50 GPM having suspended solids in the inlet ranging from 8 - 60 ppm with an expected outlet content of 0 - 8 ppm. Total solids content in the inlet water will range from 1900 - 4700 ppm. Diatomite filter aid will be Johns-Manville Celite #545. Water temperature will range from 40 - 120 deg. F. pH value will be regulated between 8.5 - 9.5. Filter cake and accumulated solids are to be discharged from the filter in a semi-dry state, air blown and liquid free. All water required for flushing and backwashing the filters is to be returned to the dirty water tank for reuse as filter feed. This water cannot be discharged to sewers. Area of precoat filter surface of each filter is to be 300 sq. feet. Unit flow rate to filters is not to exceed .3 GPM per square foot - nominal flow being 75 GPM through filter when supplying 50 GPM to process.

The secondary filters are pressure vessels using diatomaceous earth on stainless steel woven mesh flexible septa.* (Refer to Figure #12) There are two semi-automatic units each having 300 square feet of surface area with controls arranged so that the "on-stream" unit will be automatically shut down and put into "blow-down" phase by the cycle timer or by excessive differential pressure across the tubes, whichever occurs first, and the "stand-by" unit will be automatically brought on stream. Removal of the spent filter-aid and recharge is accomplished manually through removal of the detachable bottom of the filter housing. During the "blow-down" phase prior to removal of filter-aid, all water is pressed out of the vessel and from the spent filter-aid, by air pressure, which forces the water through a wool felt filter at the bottom of the vessel. This feature permits the water on the dirty side of the filter to be re-used, thereby avoiding the necessity to discharge any circulating "chain" cleaning water. The filters were sized for twelve hour duty so that re-charge of diatomaceous earth could be accomplished by maintenance personnel on the day shift. Under normal circumstances, for example, Filter "A" put "on-stream" at 10 A.M. would be taken off stream at 10 P.M. and be left in "blow-down" phase until the maintenance man coming on duty at 8 A.M. services it. "A" filter would be ready to put on stream at 10 A.M., when "B" filter which was brought on stream at 10 P.M. the previous night, will go off-stream after its twelve hour cycle has been completed.

Under abnormal circumstances, such as a sudden heavy loading, filters will go off-stream due to high pressure before completing the twelve hour cycle. In such cases, maintenance personnel adjust to the new condition and gradually work the equipment into a normal operating mode. Scheduled twelve hour cycle life is attained about 90% of the time. Piping is arranged so that the diatomite filters will operate at a constant flow rate and at constant head. Under such ideal conditions, it is unlikely that diatomite would be dislodged from the septa due to hydraulic shocks such as occur when a valve is suddenly opened or closed.

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*Footnote #1 - Septa are tubes vertically suspended in the dirty water.

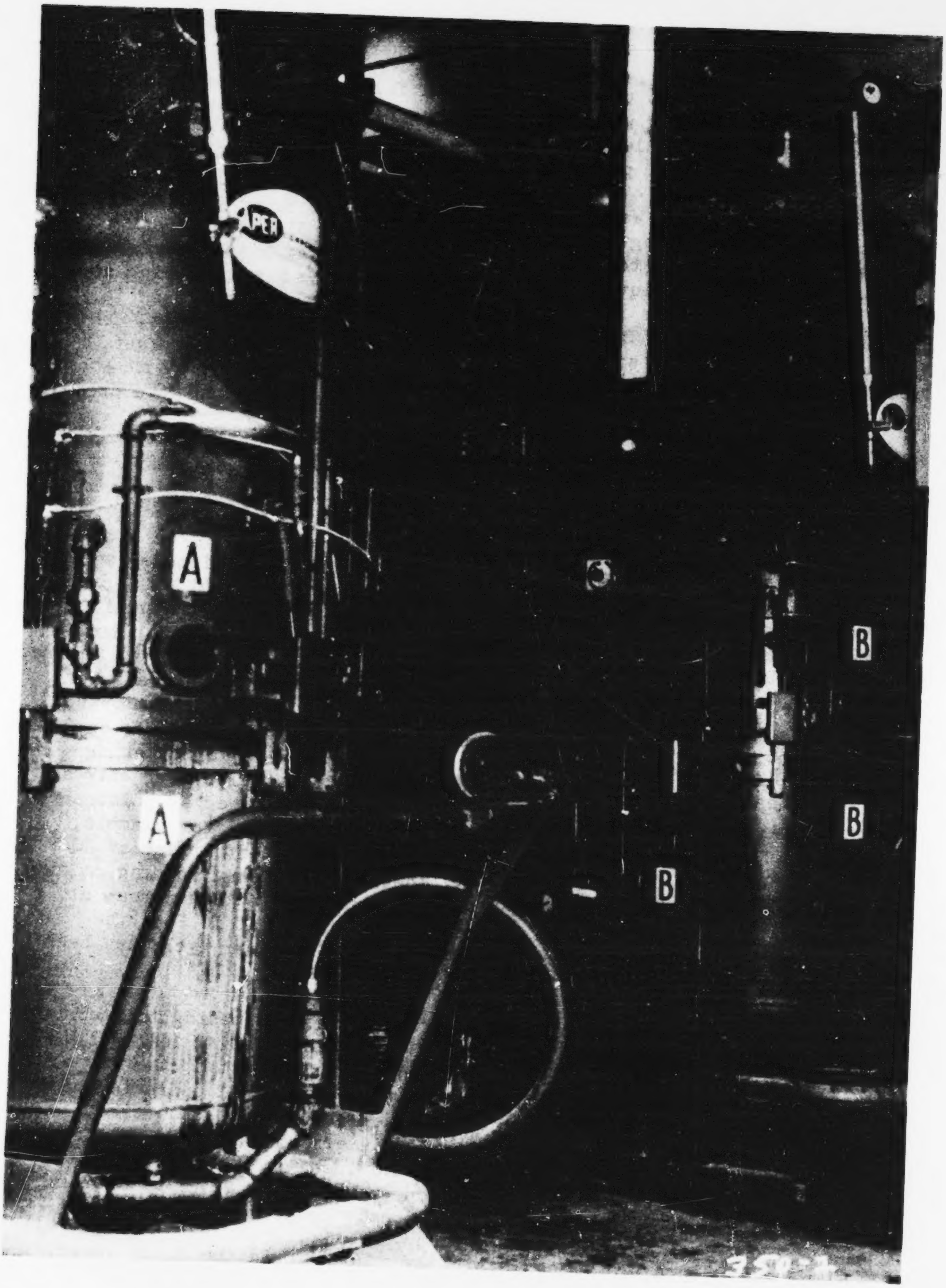

FIGURE 12 - DIATOMACEOUS EARTH FILTERS

To provide such conditions it is necessary to have certain accessories for a good diatomite filter installation, notably a dirty water tank, a supply pump and a filtered water tank, together with level controls.

Filter-aid is supplied with 25# of diatomite as precoat in the "pot" or detachable bottom of the filter. The remaining 50# of the 75# charge is fed uniformly by dry feeder and vortex mixer to the dirty water tank as "body" feed over the twelve hour cycle.

Dirty Water Tank.

Design Criteria:
Tank to be filled with level control to provide a uniform suction head on the dirty water filter feed pumps.

a 6' diameter 14' high open top tank containing about 1000 gallons at the half-full point provides the suction head condition for the centrifugal pump which supplies water to its associated filter. At rated flow of 75 gallons per minute, the pump discharges filtered water to an open funnel about 6' higher than the filter outlet. From the funnel the filtered water passes to the clear (filtered) water tank. If, however, the level in the dirty water tank falls below 6' above the tank bottom, the level controller diverts filtered water from the filtered water tank to the dirty water tank until such time as the dirty water tank level is restored to about 7' above the bottom. The level control then restores the flow of filtered water to the filtered water tank. With a constant suction level thus provided, and a constant height of discharge above the pump, a steady flow through the filter is assured with minimum fluctuation in pressure conditions to cause filter-aid dislodgement. Flow through the filter will, of course, vary from a maximum at the beginning of the cycle to a minimum at the end, because of the increasing pressure drop across the media. The function of the dirty water tank is therefore to provide a constant suction head on the filter pump.

Filtered Water Tank.

Design Criteria:
Tank capacity must be adequate to provide for varying process demands.

The filtered water tank is the same size as the dirty water tank. It serves as a surge tank to provide for the varying demands of the process. An automatic level control device operates a valve to maintain this tank in a full condition by admitting softened city water as required. An overflow pipe also connects to the dirty water tank to provide storage of excess filtered water should demand for "overspray" and "binder-mix" water cease while "chain" cleaning continues. Gauge glasses are provided on each tank for ready determination of level. Figure #13 shows both tanks with the filtered water tank on the left and the dirty water tank at the right.

FIGURE 13 - FILTERED AND DIRTY WATER TANKS

Cartridge Filters.

Design Criteria:
Pass 170 GPM water pH 8.5 - 9.5 having inlet suspended solids content of 0 - 8 ppm and expected outlet content of 0 - 6 ppm with pressure drop from 2 to 15 psi.

Filtered water from the filtered water tank is pumped through a cartridge filter station to the various points of use in the process. The cartridge filters use Fiber Glass cartridges made at Plant #3. The cartridge filters are not required for added clarity of the water. They were installed as a final filter to protect the system should a failure of the diatomite filters occur. The precaution has been valuable in a few instances, such as septa failure and in collecting fungus accumulations.

1000 psi Chain Cleaning Supply.

Design Criteria:
Tank to be provided with level control to maintain a constant suction head on high pressure pumps.

Filtered water is admitted to a small supply tank served by a float controlled valve. Water from this tank is fed to any of three reciprocating triplex horizontal plunger pumps, two of which are rated at 37 gpm each, while the third is rated at 20 gpm.

The 1000 psi header to which the three pumps are connected is fitted with an air operated back pressure control valve which maintains a uniform pressure on the line supplying the cleaning nozzles. Operating pressure has been maintained at 800 psi throughout the operating phase of the project, this pressure being adequate to clean the "chain". At 800 psi one pump serves the load.

Overspray Supply.

Two overspray centrifugal pumps each rated at 20 gpm at 200 psi receive water from the same supply tank which serves the 1000 psi "chain" cleaning pumps. Pressure regulators are provided at each machine but these are set at 200 psi in all cases. One pump carries the load.

pH Control.

Filtration of the resinous "chain" cleaning mixture is feasible, but is believed to require the addition of ammonia to a pH range of 8.5 - 9.5 to stabilize the resin. It is believed that at lower pH ranges precipitation of resin occurs which causes rapid "blinding" of the media and tubes with suspended resin. In support of this belief, aqueous ammonia is fed at constant rate by a chemical feed pump to the inlet of the diatomite filter supply pumps. Automatic control is not used, but pH determinations are made at approximately four hour intervals which serve to provide an approximate pH range of 8.5 - 9.5. A small percentage of readings taken fall outside the range. Use of a pH controller is planned to determine if closer control is warranted.

Flow Chart.

Figure #7 is a diagram of the water flow in the process. At Cleaning Station "S" 1000 psi water is directed at the "chain" and thereafter falling with entrained resin and glass fiber to the floor trench, flows to scrap pump "A" where coarse fiber is screened and extruded in a damp condition to a waste disposal bucket. The screened water leaving "A" is directed to either of two centrifugal rubber lined slurry pumps "B-1" and "B" which deliver the abrasive water to the primary filters "D" where fiber that passed through the coarse screen of the scrap pump is removed.

The filtrate from "D" is pumped to the dirty water tank "E" at which point diatomaceous earth filter-aid is added as "body feed" before the water is pumped to diatomite filters "F". The clear filtrate from "F" passes to the filtered water tank "G" which serves as a reservoir to meet the varying demands of the system. Fresh city water "make-up" to the system, after softening at "M", is admitted to tank "G" by a level control valve to maintain a full reservoir of clear water. Water from "G" then is pumped at 50 psi to the process, first passing through emergency fiber glass cartridge filter station "H".

On the basis of daily meter reading, average flows of 15 gpm are sent to two wet dust collectors from which the overflow to pump "C" is returned to primary filter "D". 12 gpm go to the binder-mix room from which the binder is pumped to the fiber glass machine and is later evaporated. 3 gpm are sent to solids removal showers on the primary filters "D". An average flow of 2 gpm serves three wash hoses at the forming end of the machine. Each hose requires 50 gpm for short periods. The estimated average flow from these intermittent cleaning uses is drained to the floor trench and returned to "A". 60 gpm is delivered to supply tank "J" from which 12 gpm is pumped at 200 psi to "overspray" nozzles at the fiber glass machines from which it is subsequently evaporated. The remaining 48 gpm from "J" are delivered at 1000 psi to the "chain" cleaning stations at "S".

Treatment Tank and Discharge Weirs.

Other features noted on the flow chart are incidental to the normal cycle above outlined or are not related to the process. "K" is a 30,000 gallon open top steel tank located out of doors and fitted with a small aerator. It is a holding tank to receive excess flows from the sump pump "C", such as would be occasioned by a failure of pump "B" or would result from water discharged from putting out a fire on the fiber glass machines or

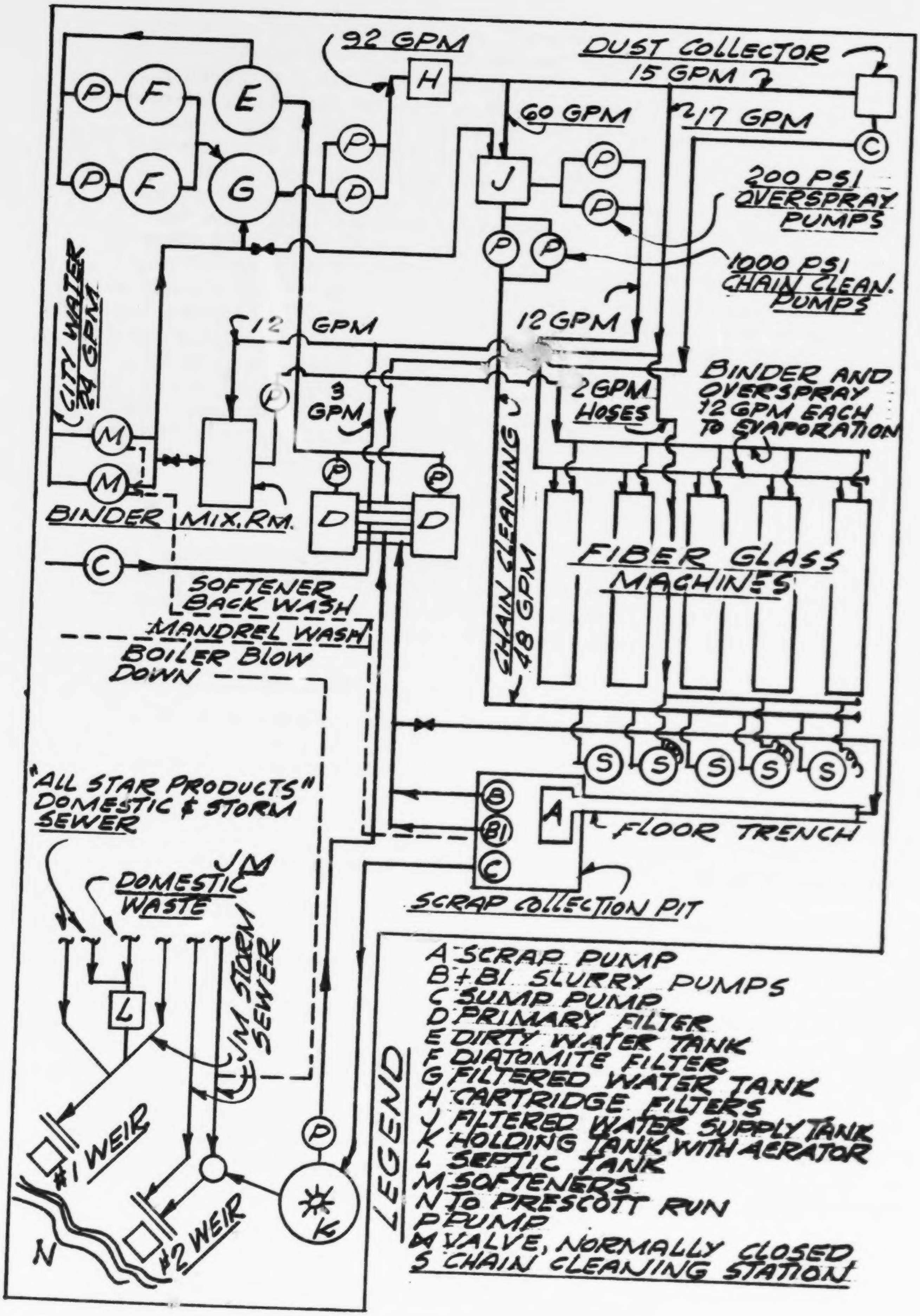
92 GPM
H
DUST COLLECTOR
15 GPM
60 GPM
17 GPM
P
F
E
G
J
C
200 PSI OVERSPRAY PUMPS
1000 PSI CHAIN CLEAN. PUMPS
CITY WATER 74 GPM
12 GPM
12 GPM
3 GPM
2 GPM HOSES
BINDER AND OVERSPRAY 12 GPM EACH TO EVAPORATION
CHAIN CLEANING 48 GPM
M
BINDER
MIX. RM.
D
FIBER GLASS MACHINES
SOFTENER BACK WASH
MANDREL WASH
BOILER BLOW DOWN
S
B
B1
A
FLOOR TRENCH
SCRAP COLLECTION PIT
"ALL STAR PRODUCTS" DOMESTIC & STORM SEWER
JM DOMESTIC WASTE
L
JM STORM SEWER
#1 WEIR
#2 WEIR
N
K
LEGEND
A SCRAP PUMP
B+B1 SLURRY PUMPS
C SUMP PUMP
D PRIMARY FILTER
E DIRTY WATER TANK
F DIATOMITE FILTER
G FILTERED WATER TANK
H CARTRIDGE FILTERS
J FILTERED WATER SUPPLY TANK
K HOLDING TANK WITH AERATOR
L SEPTIC TANK
M SOFTENERS
N TO PRESCOTT RUN
P PUMP
⋈ VALVE, NORMALLY CLOSED
S CHAIN CLEANING STATION

FIGURE 7 - FLOW CHART - SCHEMATIC
WASTE RECLAMATION SYSTEM

elsewhere from sprinklers. "Backwash" water from the softeners and a caustic mandrel wash discharge from the mandrel cleaning tank also go to tank "K" via sump pump "C". "K" is equipped with a pump and pipe line for return of water to the process. The high causticity of mandrel wash water has prevented return of the water to process use because of foaming. Tank "K" is also fitted with a valve which would permit pumping of contents of "K" to #2 Weir and thence to Preston Run tributary. This valve is enclosed by fence and locked gate, accessible only to delegated personnel. #2 Weir also receives water from two Johns-Manville storm sewers. (Refer to Figure #14). A third Johns-Manville storm sewer discharges to #1 Weir, which also receives flow from a neighboring plant sewer owned by "All Star Products" as well as domestic waste from a septic tank on "All Star Products" property into which the domestic waste from both "All Star Products" and Johns-Manville Plant #3 discharge. The complicating sources of water entering this tributary to Preston Run make the use of flow readings at #1 and #2 Weir questionable for detailed analysis purposes. Nevertheless, the general downward trend of these flows correlates with the reduced water purchases made by Plant #3 after operation of the project started.

Schedule.

The Design & Construction phase of the project required one year -vs- an estimated six months schedule. Each equipment item and its supporting pits, trenches, piping and wiring received the following phases of consideration before installation could start:

	Time element *
Federal Approval of Preliminary Plans	3-1/2 months to 12/15/67
Design	4-1/2 months to 5/5/68
Write Specifications	1-1/2 months to 6/15/68
Competitive Bidding	1 month to 7/15/68
Approval of Purchase (FWPCA)	1/2 month to 8/1/68
Purchase	1/4 month to 8/7/68
Fabricate and Ship	3/4 month to 9/1/68
Installation	4 months to 1/7/69

Total . . . . 16 months to 1/7/69

* Time element is given as maximum time required. For example, although the last major purchase item occurred on August 7th, many purchases were made prior to this time as rapidly as bidding was completed.

FIGURE 14 - #2 WEIR

Operation started on January 7, 1969. Construction was completed on February 4, 1969 when work was finished on the treatment tank.

After FWPCA approval of preliminary plans, some twelve and one-half months were required to effect the installation. Actual construction and installation was accomplished in four months, while planning and purchase preparation required eight and one-half months. While it is not unusual for the planning phases of a project to require as much time as the installation, the initial estimate of six months for planning and installation was not achieved. In a subsequent installation at our new Winder, Georgia fiberglass plant, in which the closed system at Defiance 003 was closely followed, design started in July of 1968 and production started in August of 1969. Some of the time element in this instance was dependent on the construction of other features of a new plant. Depending upon the urgency, a closed system of this nature should be available for use within eight to twelve months after approval.

Unusual Construction Features.

The normal twenty-four hour continuous operation of a fiberglass plant presented problems from the standpoint of lost production of fiberglass. Scheduling of outage was based on maximum speed of converting the product units. This project was developed from a prior trial of about ten months length on #5 product unit at Defiance 003. In this project it was necessary to revise the travel of the collection conveyor to permit downward blow-off of fiber and resin from the conveyor chain. In the current project it was necessary to carry out conveyor revisions to the remaining four product units and install a sluice trench under all units for reclamation of the conveyor chain wash water. The trench was installed first, but due to production requirements, had to be installed in five separate sections so that interruption to production occurred on but one machine at a time. Each section of trench was installed in a twenty-four hour day. Revision of the collection conveyor was accomplished by scheduling each product unit down for five days at a time. Conversion was carried out on a twenty-four hour, around the clock, basis to minimize outage. After conversion, chain cleaning was accomplished with fresh water at 200 psi initially, and eventually at 1000 psi and the water discharged to Preston Run.

Prior to the conversion of all five product units, installation had been carried forward on the construction of the scrap collection pit and on the installation of the primary and secondary filters in the water room. In the first product unit conversion (#1 unit), city water was supplied to the chain cleaning nozzle at 200 psi from the overspray pumps until such time as the normal 1000 psi pumping system was ready. Cleaning was adequate at 200 psi on this unit. During the foregoing conversion period, discharged water from the chain cleaning operation was sluiced through the scrap pump which removed coarse glass fibers. The water was routed to one of the two transfer pumps which send the water to the primary screens. After passing through the 60 mesh screens, the water was diverted from its normal course through the secondary (diatomite) filters to the stream.

When the diatomite filter installation was completed and after conversion of all Product Units, the diatomite filters were put on stream and the filtered water returned to re-use as chain cleaning water, as overspray and as binder mix water.

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V

OPERATION OF PROJECT

An objective of the project was to operate the system as planned for twelve months and to collect pertinent information during this period.

A twelve month period of successful operation was achieved as of January 15, 1970. The system performed substantially as anticipated in continuous twenty-four hour per day, seven day per week service. Comprehensive sampling and analysis of the water in the system and of water discharged was made and recorded.

Four significant unanticipated actions occurred which temporarily interrupted operation in two instances and which adversely affected operating costs in two cases.

The first situation resulted from the failure of diatomite filter septa during February and March of 1969, in the first two months of operation. Diatomite filter outage occurred for a few days until new tubes were replaced. The septa failed due to plating of sticky solids over the flow spaces in the septa. This problem was corrected by changing the diatomite feed from a single charging at the beginning of a cycle to initial charging of one-third of the diatomite and continuous "body" feeding of the remaining two-thirds during the twelve hour filter cycle. Temporary interruption occurred, but operating costs were not increased

The second unexpected action was the development of foam when attempts were made to reuse the miscellaneous "non-chain cleaning" waters in the chain cleaning circuit. The high pH of these waters served to generate foam which threatened shut down of the circulating system because of inability of filter pumps to handle the flow at lower suction heads than planned. Reclamation of this water was abandoned in favor of routing it to a new sewer connection to the City of Defiance treatment plant. Added operating cost will result from municipal sewage treatment charges.

The third unplanned problem resulted when a small pipe line became plugged on April 18th with a gray rubber-like non-sticky slime-like substance. This threat to recirculation was so serious that consultants were retained and re-circulation was halted until understanding of this development was achieved. The blockage was identified as a fungus and after study a suitable fungicide was fed to the system which has successfully contained the fungus. Recirculation was restored April 30th after a twelve day interruption. Added operating costs resulted from the feeding of fungicide to the system.

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The fourth unexpected condition resulted from a production change in August, 1969, when a new method of applying the binder caused extra consumption of binder. The binder savings which were planned as part of this project turned into losses in August and much reduced savings in the ensuing months. Eventually binder savings were largely restored after production personnel discovered the knack of handling the new method. Added costs occurred for the remainder of the period over those obtained during the first six months.

The foregoing unexpected developments hindered but did not prevent the successful operation of the recirculating system for the twelve month grant period.

VI

EVALUATION PROGRAM

Operating Parameters.

The following parameters are considered to be significant:

Suspended solids concentration
Dissolved solids concentration
Phenolic concentration
pH
Water consumption
Discharge to stream

Testing Program.

Sampling at eight points was made once per week on Thursday. The samples were analyzed for phenol, suspended solids, pH and total solids content. The sampling points, located on Figure #16, are:

#1 Outside tank
2 Downstream of discharge
3 Weir #1 (discharge)
4 Weir #2 "
5 Entering Primary Filter West
6 Entering dirty water tank, before diatomite filtration
7 Entering clear water tank, after diatomite filtration
8 Supply tank, after make-up dilution and cartridge filter

Unit Performance.

Data for the month of November is computed in Section VII. It shows that the average daily suspended solids removal amount to:

Unit	Lbs.	%	
Scrap Pump	2400	32.6 /	Estimate
Primary Filter West (chain cleaning)	2400	32.6	Calculation
Primary Filter East (dust collector)	2500	34.2	Estimate
Diatomite Filters	43	.6	Calculation
Total	7343	100.0	

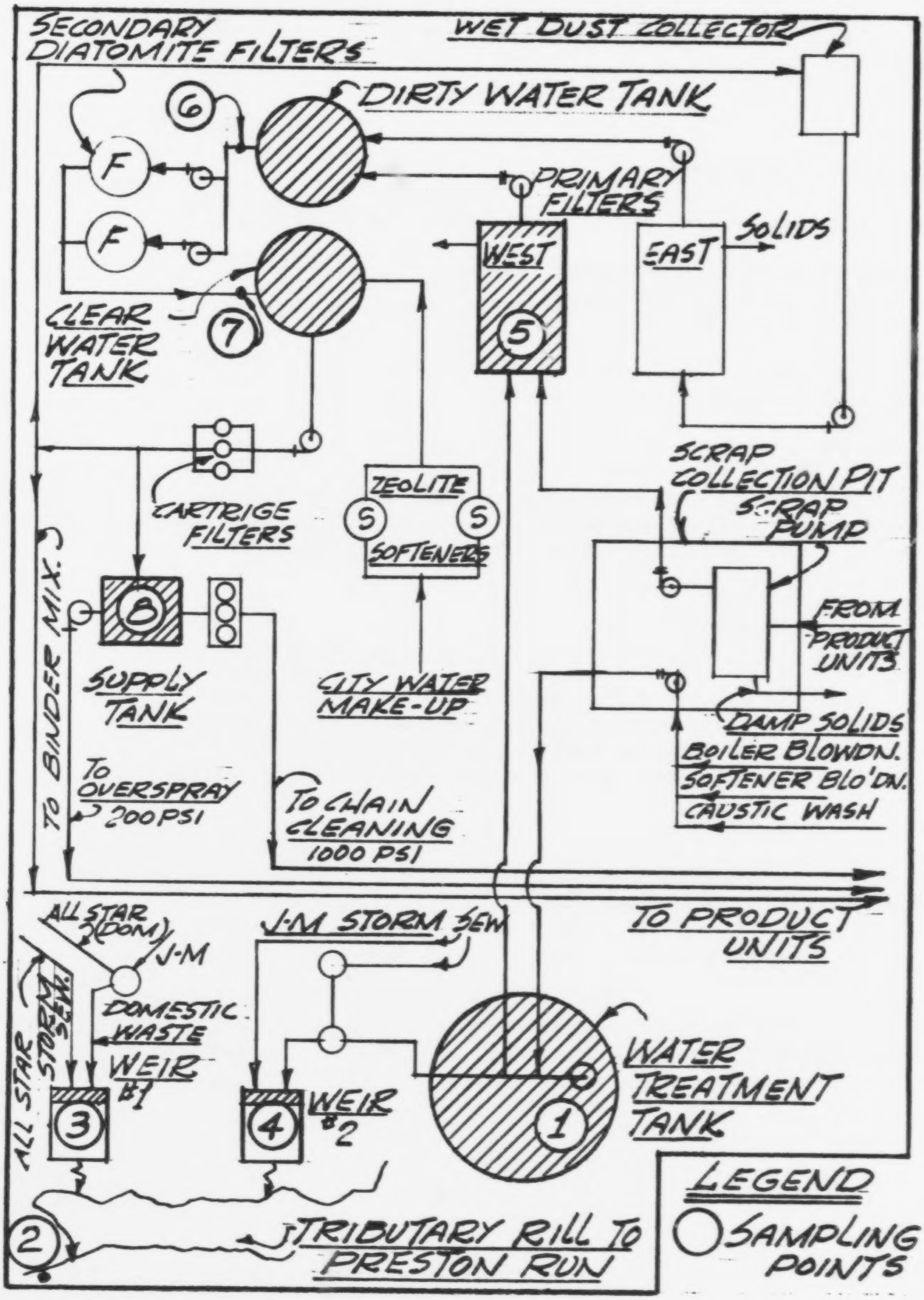
SECONDARY
DIATOMITE FILTERS
WET DUST COLLECTOR
DIRTY WATER TANK
6
F
F
PRIMARY
FILTERS
WEST
EAST
SOLIDS
5
CLEAR
WATER
TANK
7
CARTRIGE
FILTERS
ZEOLITE
S
S
SOFTENERS
SCRAP
COLLECTION PIT
SCRAP
PUMP
FROM
PRODUCT
UNITS
8
SUPPLY
TANK
CITY WATER
MAKE-UP
DAMP SOLIDS
BOILER BLOWDN.
SOFTENER BLO'DN.
CAUSTIC WASH
TO BINDER MIX.
TO
OVERSPRAY
200 PSI
TO CHAIN
CLEANING
1000 PSI
TO PRODUCT
UNITS
ALL STAR
(DOM)
J·M
J·M STORM SEW
ALL STAR
STORM
SEW.
DOMESTIC
WASTE
WEIR
#1
3
4
WEIR
#2
WATER
TREATMENT
TANK
1
2
TRIBUTARY RILL TO
PRESTON RUN
LEGEND
SAMPLING
POINTS

FIGURE 16 - SAMPLING POINT LOCATIONS

It is noted here that the primary filter "east" was utilized to screen dust collector waste solids and the primary filter "west" handled the chain cleaning solids remaining after prior scalping by the scrap pump. The filtrate from both primary filters was combined in the dirty water tank as feed for the diatomite filters.

The diatomite filters were therefore filtering two different process streams, one containing saw kerf from cured fiber glass, the other containing solids from uncured fiber glass. Both streams contained phenolic resin. Records were kept on the chain cleaning process but not on the dust cleaning circuit. Even so, the records kept do not show the amount of chain cleaning solids removed by the diatomite filters. The best indication of unit performance, therefore, is to estimate the total solids removed from the dust collector stream by the primary filter east. A total throughput is thus estimated from both streams. On this basis the diatomite filters can be said to have handled .6% of all solids in the streams passing through them.

System Performance.

The several parameters representative of operation are listed in Tables A-1 through A-5 in Appendix "A". Graphically, these parameters are shown in Figures discussed below:

Phenol Concentration - Discharge - Figure #17.

The high concentrations found in #1 sample (holding tank) are the result of discharges to the holding tank which were generally not from the recirculating system. Bleeding of the holding tank contents at controlled rates produced the lower values found in #4 sample (#2 Weir) and in #2 sample (Downstream of discharge).

Phenol Concentration - Recirculated Water - Figure #18.

#5 and #6 sample values before and after the primary filter west respectively, closely parallel each other. One would expect that the "after filtration" samples would have slightly lower values due to removal of suspended fiber solids and adhering phenolic resin particles. The #7 sample (after diatomite filtration) was mistakenly not analyzed for phenol, in the belief that #7 and #8 samples would have identical dissolved phenol content. Actually, the #8 sample values are consistently lower than those for #6 sample (before diatomite filters) due to filtration effects and primarily from the admission of make-up water at the filtered water tank. The general level of phenol concentrations falls in the range of 10 - 25 parts per million.

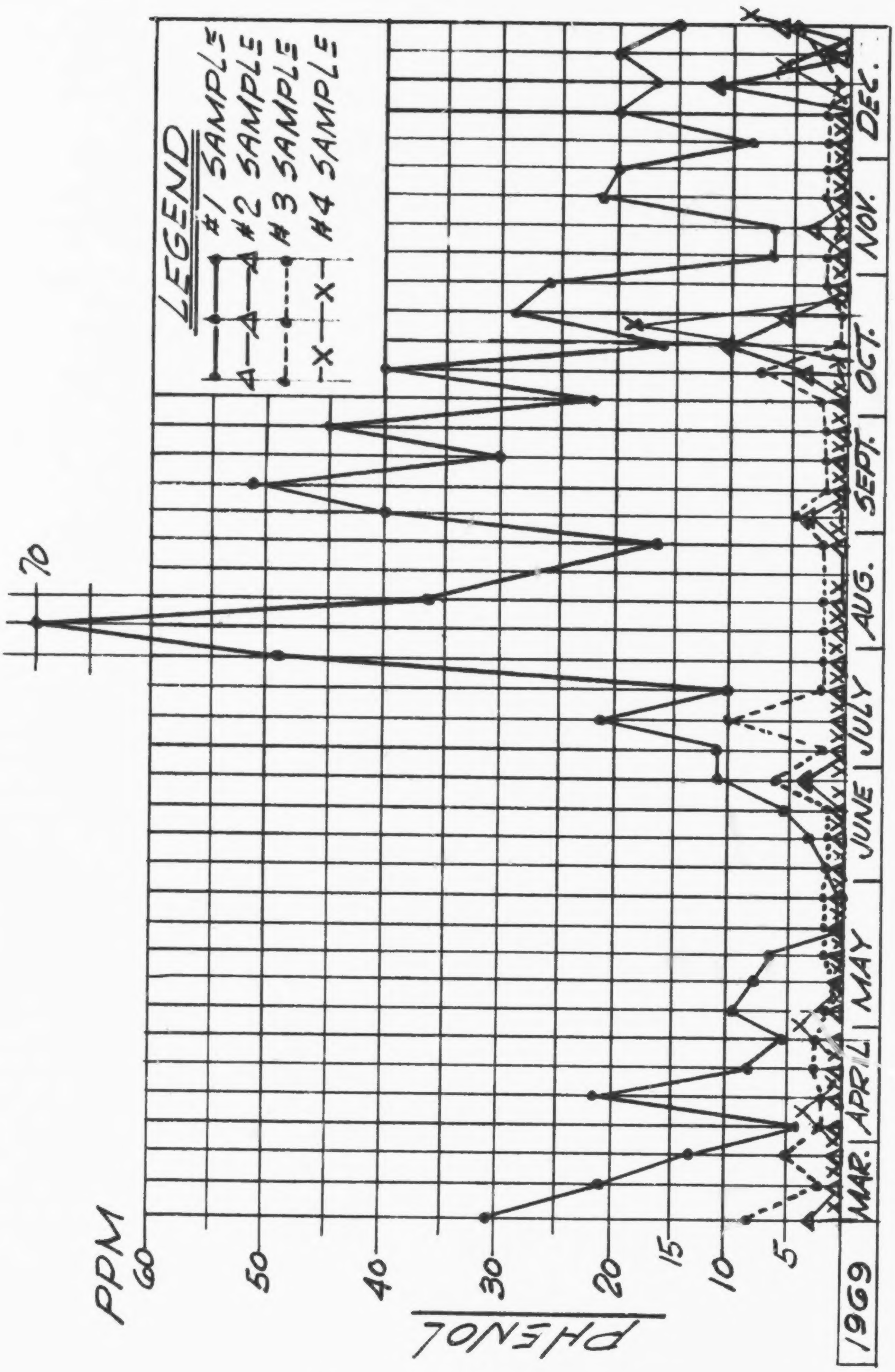

FIGURE 17 - PHENOL CONCENTRATION - DISCHARGE

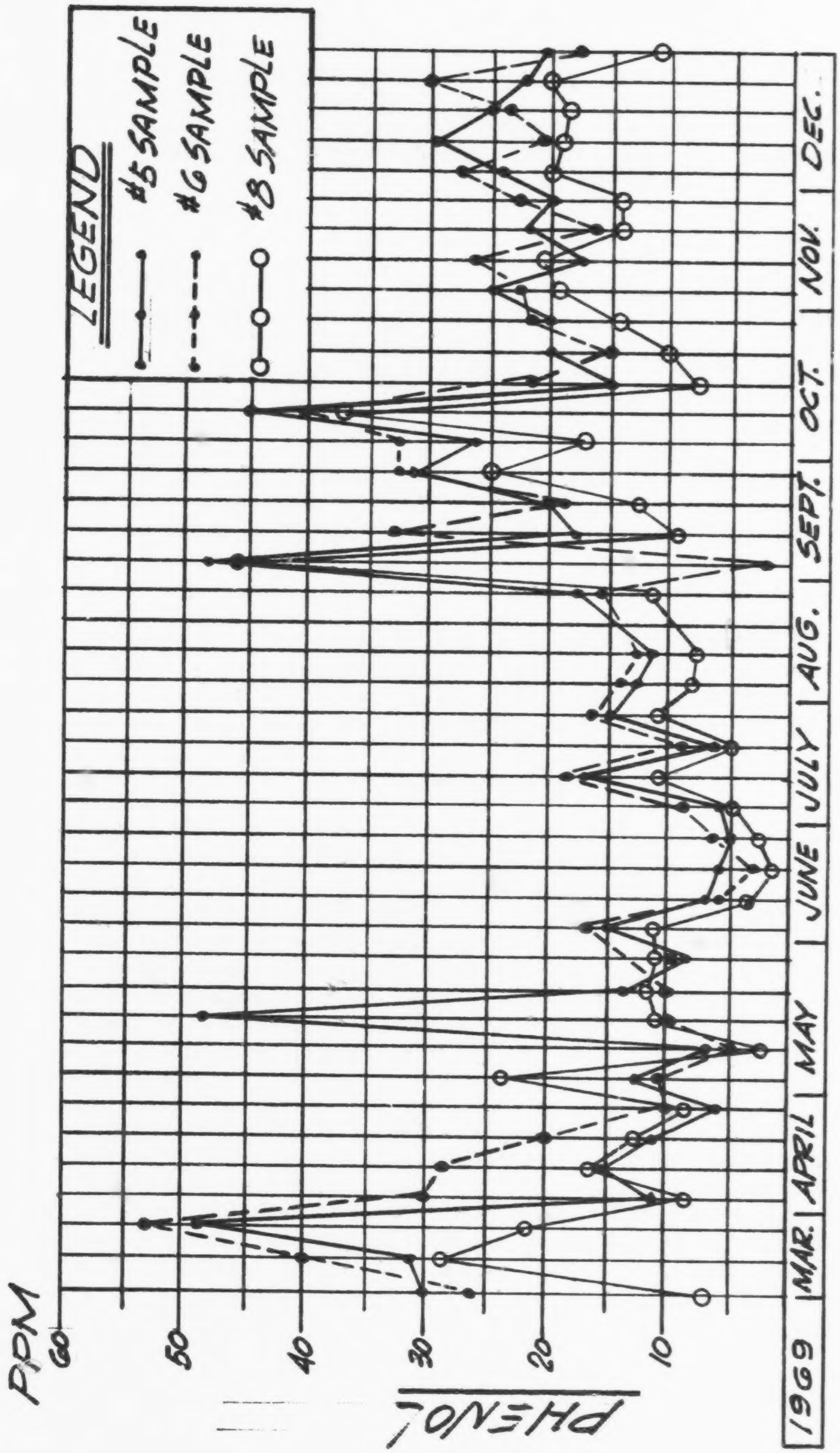

FIGURE 18 - PHENOL CONCENTRATIONS - RECIRCULATED WATER

Suspended Solids - Discharge - Figure #19.

Suspended solids in the stream below the discharge points from #1 and #2 Weirs were generally found to be in a 0 to 30 part per million range, but on several occasions exceeded this range. The principal factor affecting this condition was the manually regulated bleed from the holding tank of unfiltered water.

Suspended Solids - Recirculated Water - Figure #20.

Figure #20 clearly brings out the effectiveness of three of the four stages of filtration used. Suspended solids leaving the scrap pump and entering the primary filter West (#5 sample) had concentration in the 100 - 1000 ppm range. The water entering the diatomite filters contained suspended solids in a 25 - 100 ppm range (sample #6) and leaving the diatomite filters contained 0 to 10 ppm. The final water circulated to process, after make-up dilution and after passage through fiberglass cartridge filters contained 0 to 4 ppm of suspended solids. The final water was more than adequately clarified for intended uses, the most restrictive of which was dispersion through fine spray nozzles.

Total Solids Discharge - Figure #21.

The total solids content of Preston Run tributary water below Johns-Manville's discharge point (#2 sample) was generally less than 1000 ppm. Inasmuch as the suspended solids at this point ranged from 0 - 30 ppm, the dissolved solids amounted to approximately 970 + parts per million.

Total Solids Recirculated Water - Figure #22.

The water entering the primary filter West (#5 sample) had highly variable values, resulting from the variable suspended solids content observable in Figure #20. As suspended solids were removed the total solids values in the filtrate, sample #6, became more uniform, covering a range of 3000 - 7000 ppm. Deducting the suspended solids range of 25 - 100 ppm seen in Figure #20, the dissolved solids content ranged from about 2940 - 6940 ppm. Similarly, the filtrate entering the clear water tank (sample #7) had total solids values of 3000 - 6000 ppm and suspended solids from 0 to 10 ppm (Figure #20) or a dissolved solids content of approximately 3000 - 6000 ppm.

Total solids in the final filtrate, after make-up (sample #8) ranged from 2000 to 4000 ppm. Deducting suspended solids ranging from 0 to 4 ppm, the dissolved solids value of the final filtrate and make-up ranged from approximately 2000 - 4000 ppm. Maximum dissolved solids concentrations occurred entering the primary filter and had approximately the same value entering the secondary diatomite filter, approximately 6000 - 7000 ppm. Greater concentrations may be possible.

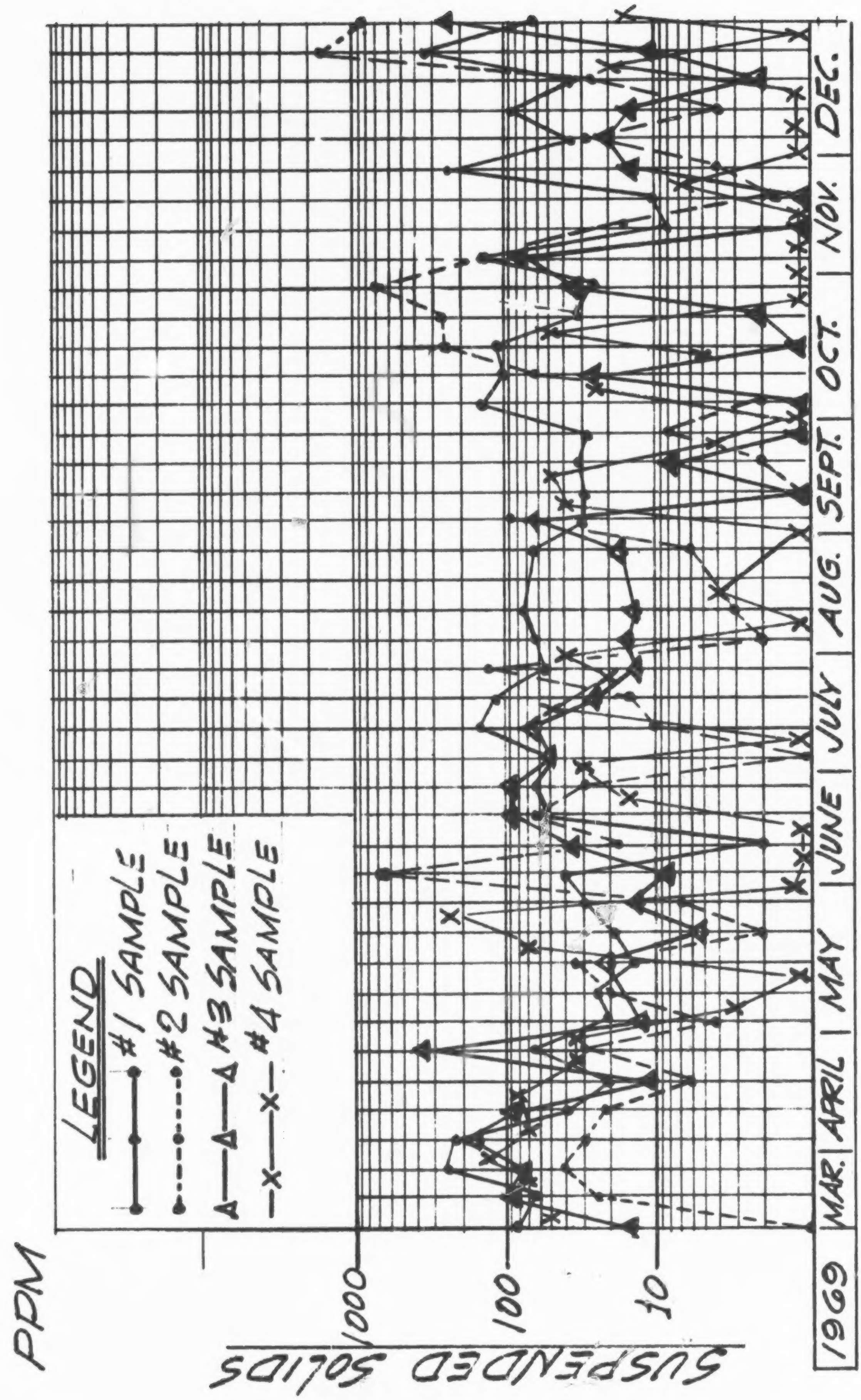

FIGURE 19 - SUSPENDED SOLIDS - DISCHARGE

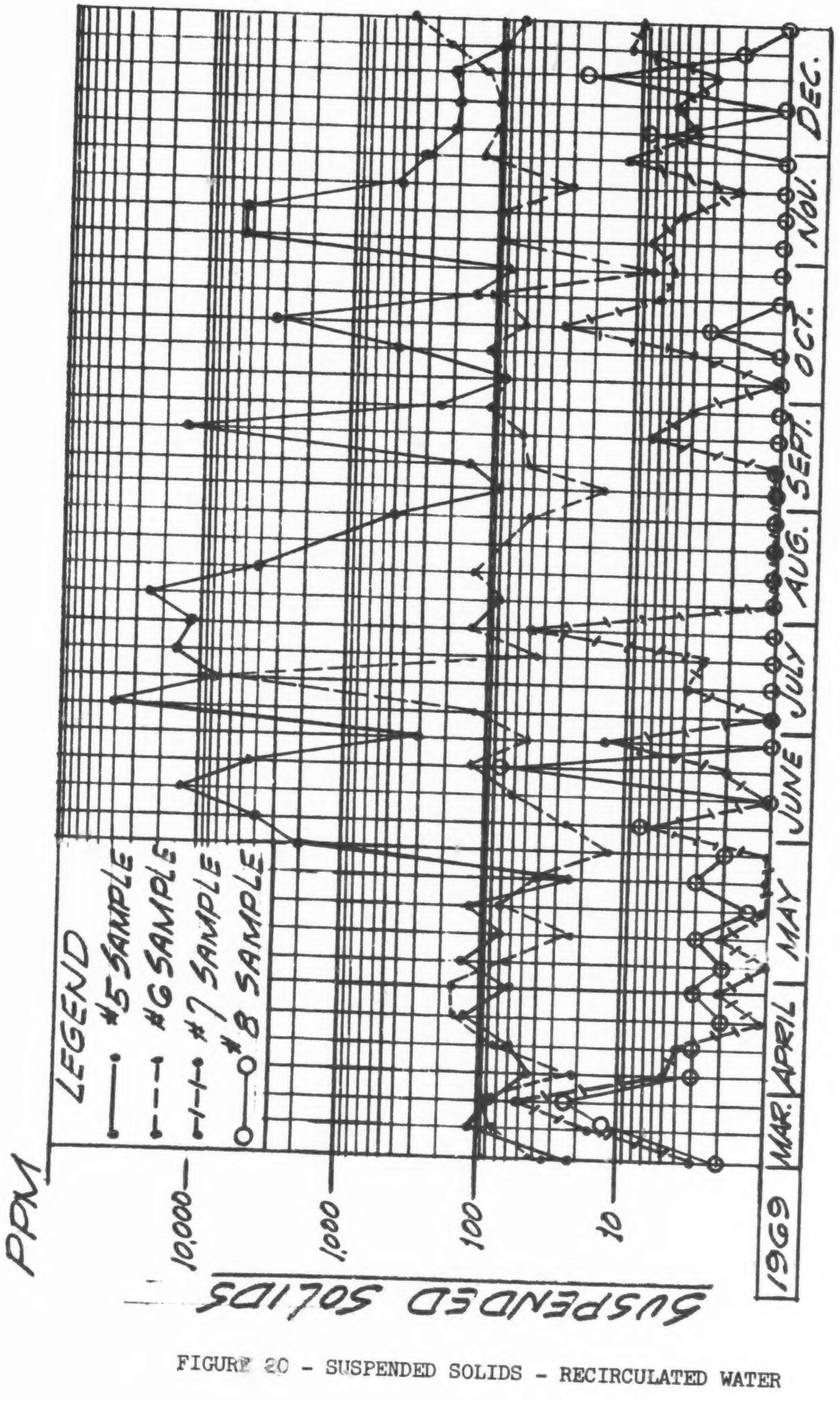

FIGURE 20 - SUSPENDED SOLIDS - RECIRCULATED WATER

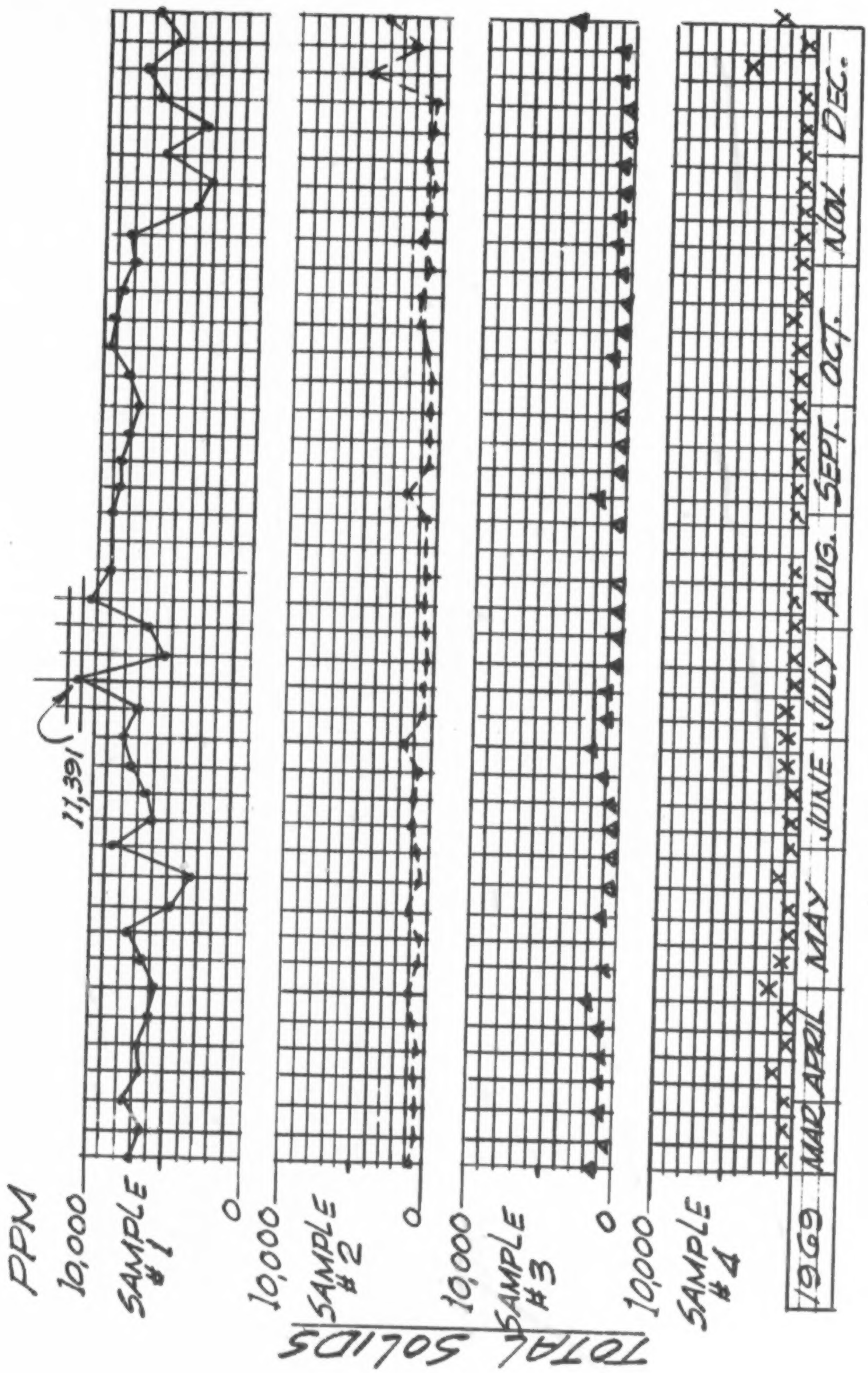

FIGURE 21 - TOTAL SOLIDS - DISCHARGE

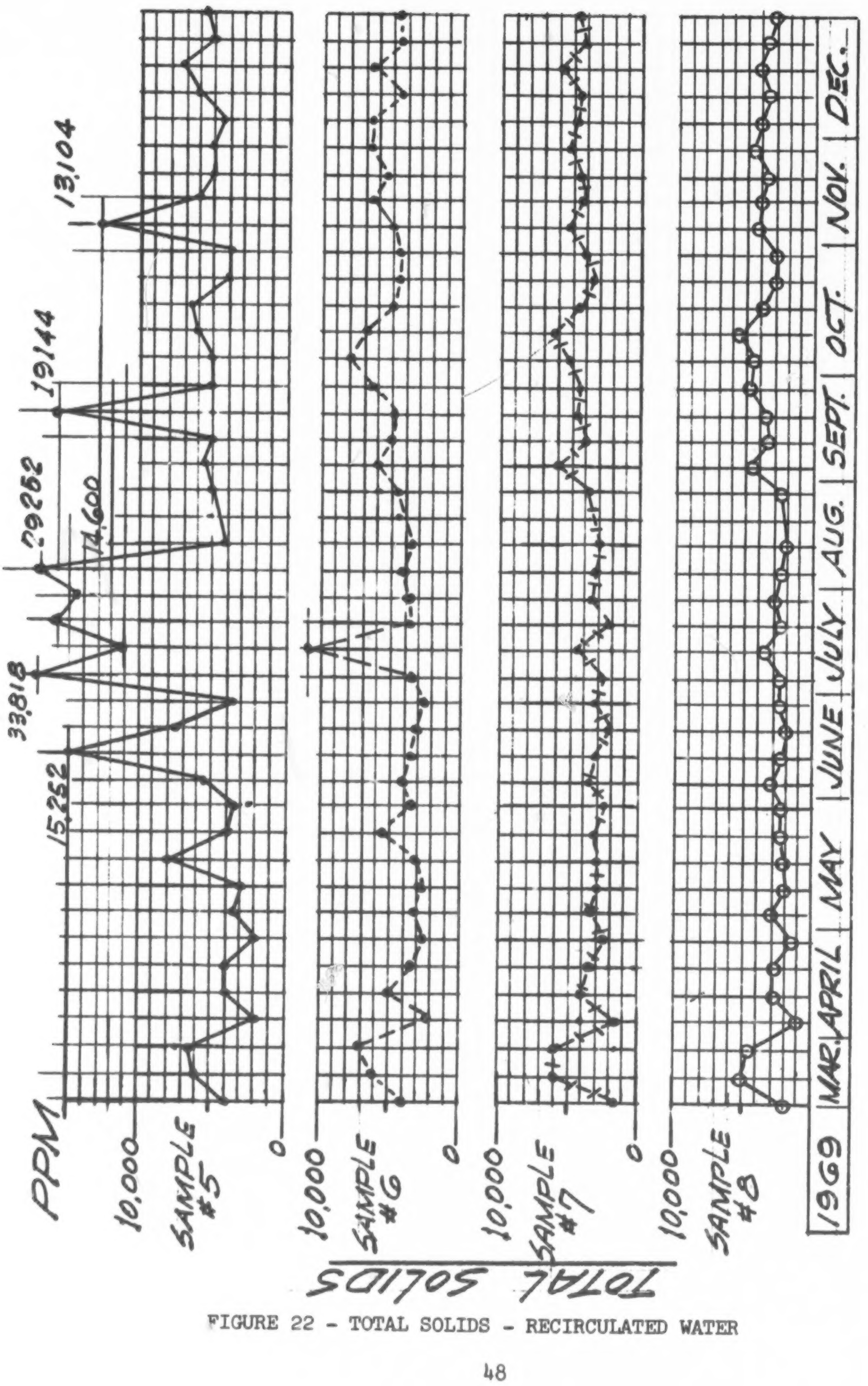

FIGURE 22 - TOTAL SOLIDS - RECIRCULATED WATER

pH values - Discharge - Figure #23.

pH values in Preston Run tributary below the discharge point ranged from about 7.2 to 8.7 (sample #2). A very high pH range of 11.0 to 12.0 was found in the holding tank, the result of containing discharges of caustic mandrel wash water.

pH values of 8.0 - 9.0 range were found at #1 Weir (#3 sample) and 7.5 to 8.5 readings were recorded at #2 Weir (#4 sample). These findings reflect the result of controlled release from the holding tank.

pH values - Recirculated Water - Figure #24.

The pH determinations for samples #5, 7 and 8 fall in a narrow range, approximately 9.3 to 9.6. This represents the result of manual addition of aqueous ammonia via chemical feeder to maintain a uniform pH value. #6 sample falls .1 to .2 pH below the remaining values. This is probably because #6 sample is the last point in the re-circulating track before ammonia addition takes place.

Water Consumption Trend - Figure #15.

Fortunately for the purposes of this project, all water is purchased from the City of Defiance. Since it is all metered, we have a perfect "before" and "after" situation which reflects accurately the degree of re-circulation being practiced. Water purchasing plummetted to almost one-third of the pre-recirculating period values when the re-circulating system started in January 1969. Consumption came up again in March and April during the period when fungus developments necessitated running "open" until corrective measures were taken. After May, with fungicide protection operative, water purchases dropped to the minimum non-process use plus process evaporation requirements.

Average Daily Discharge to Preston Run - Figure #25.

The premise of re-use of water implies that not as much water will be required. As noted above, water purchases were greatly reduced as soon as re-cycling of water started. It is also true that less water should be discharged from the plant under water re-use principles. Reference to Figure #25 shows that a substantial reduction in discharge to the stream did occur.

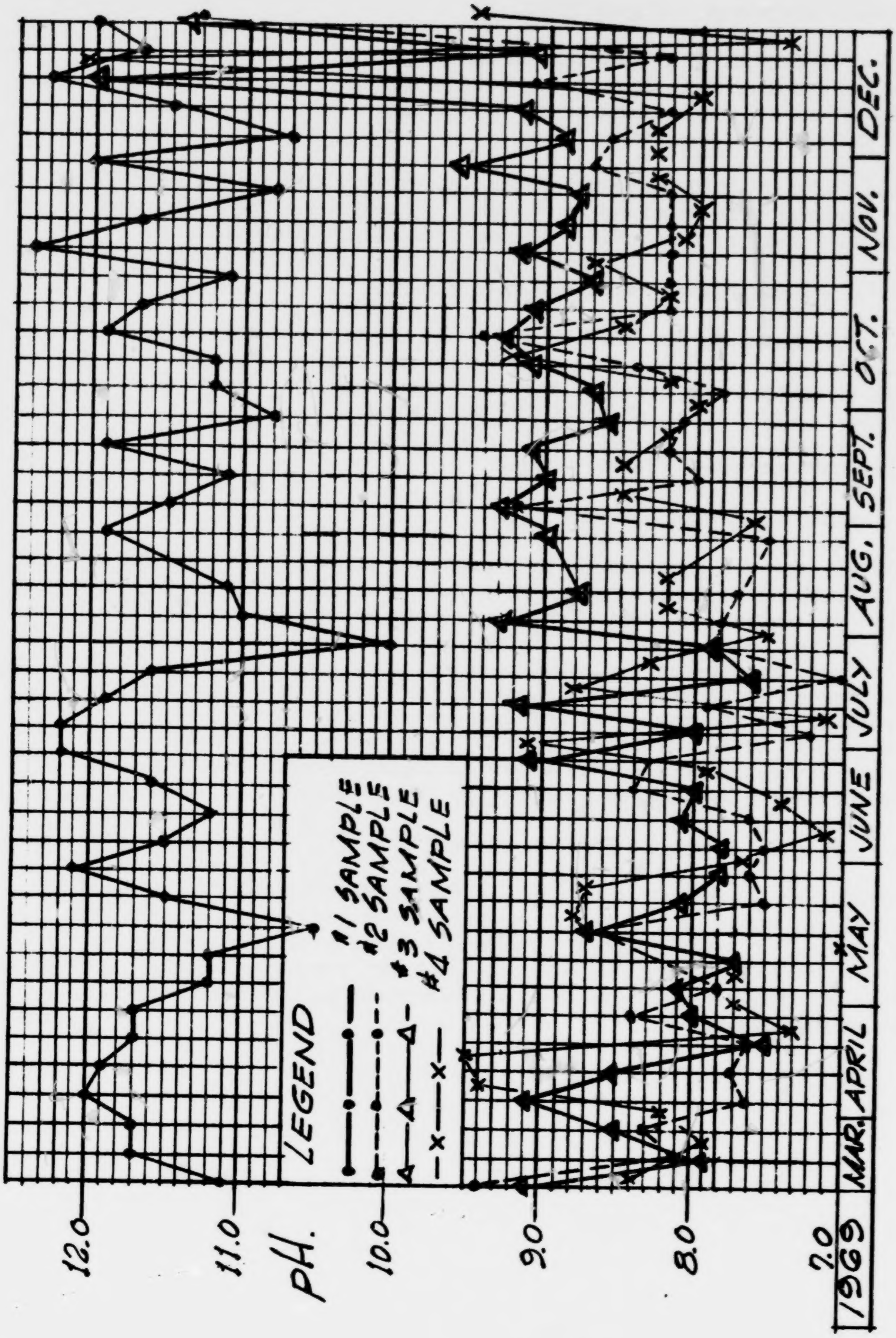

FIGURE 23 - pH VALUES - DISCHARGE

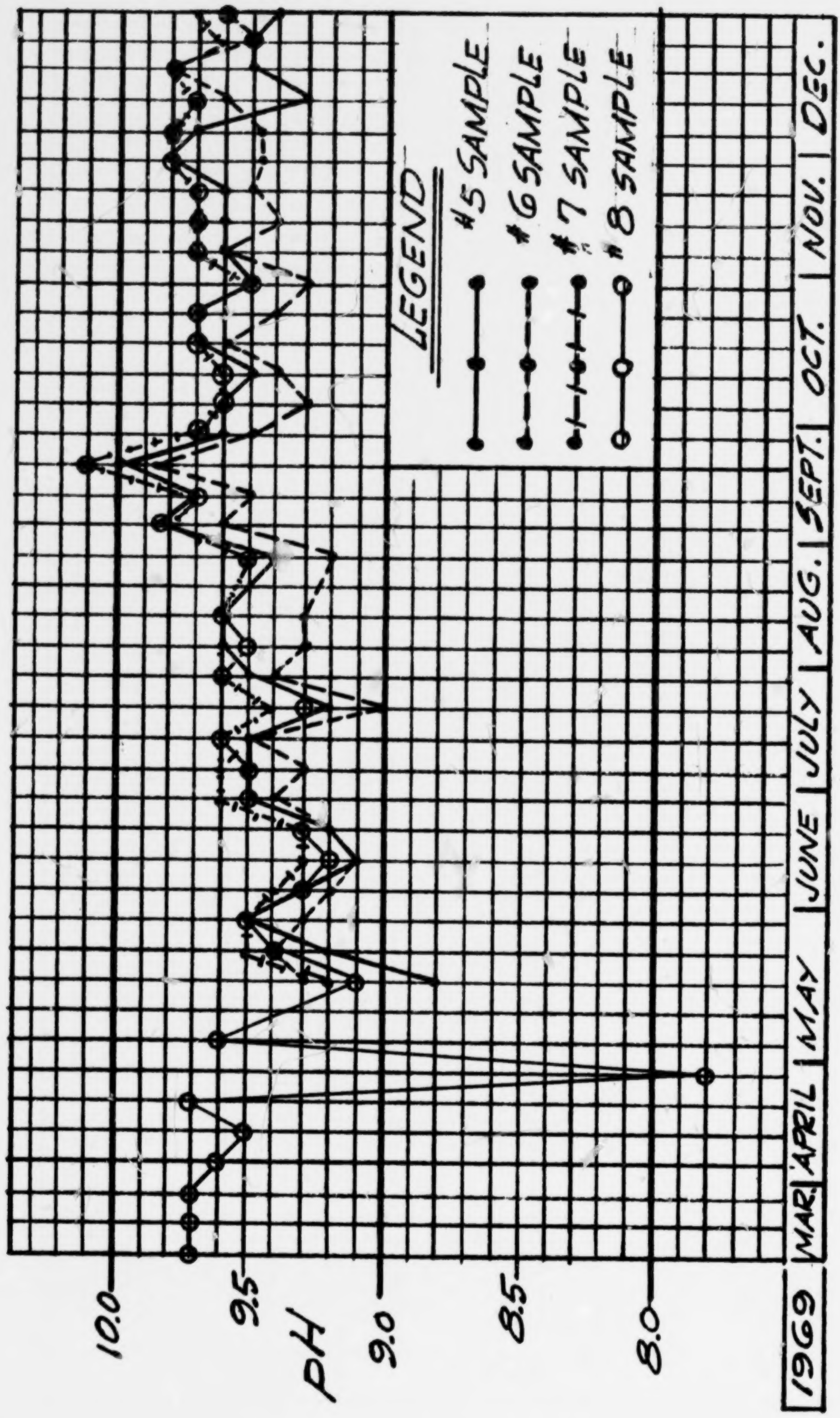

FIGURE 24 - pH VALUES - RECIRCULATED WATER

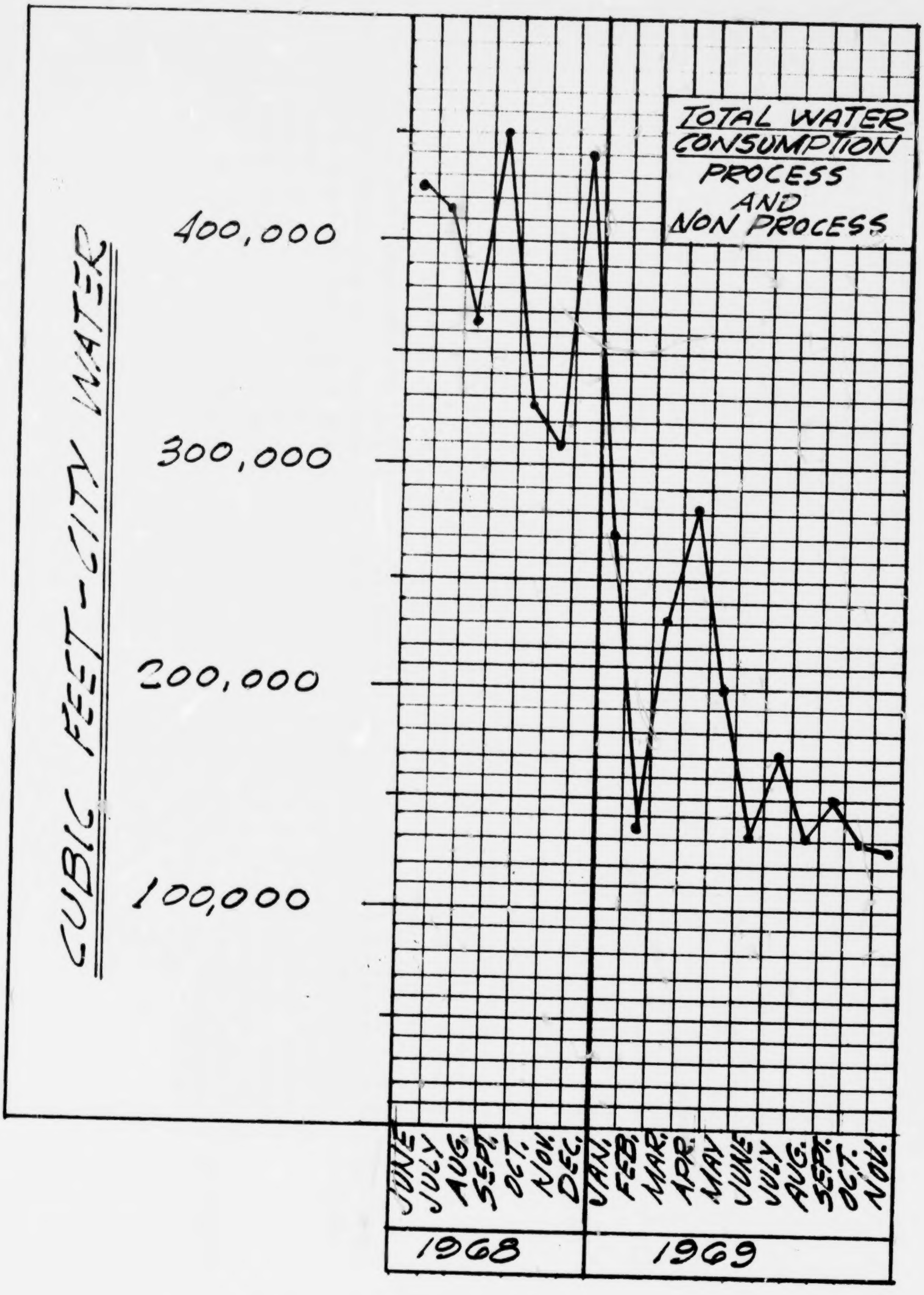

FIGURE 15 - WATER CONSUMPTION TREND

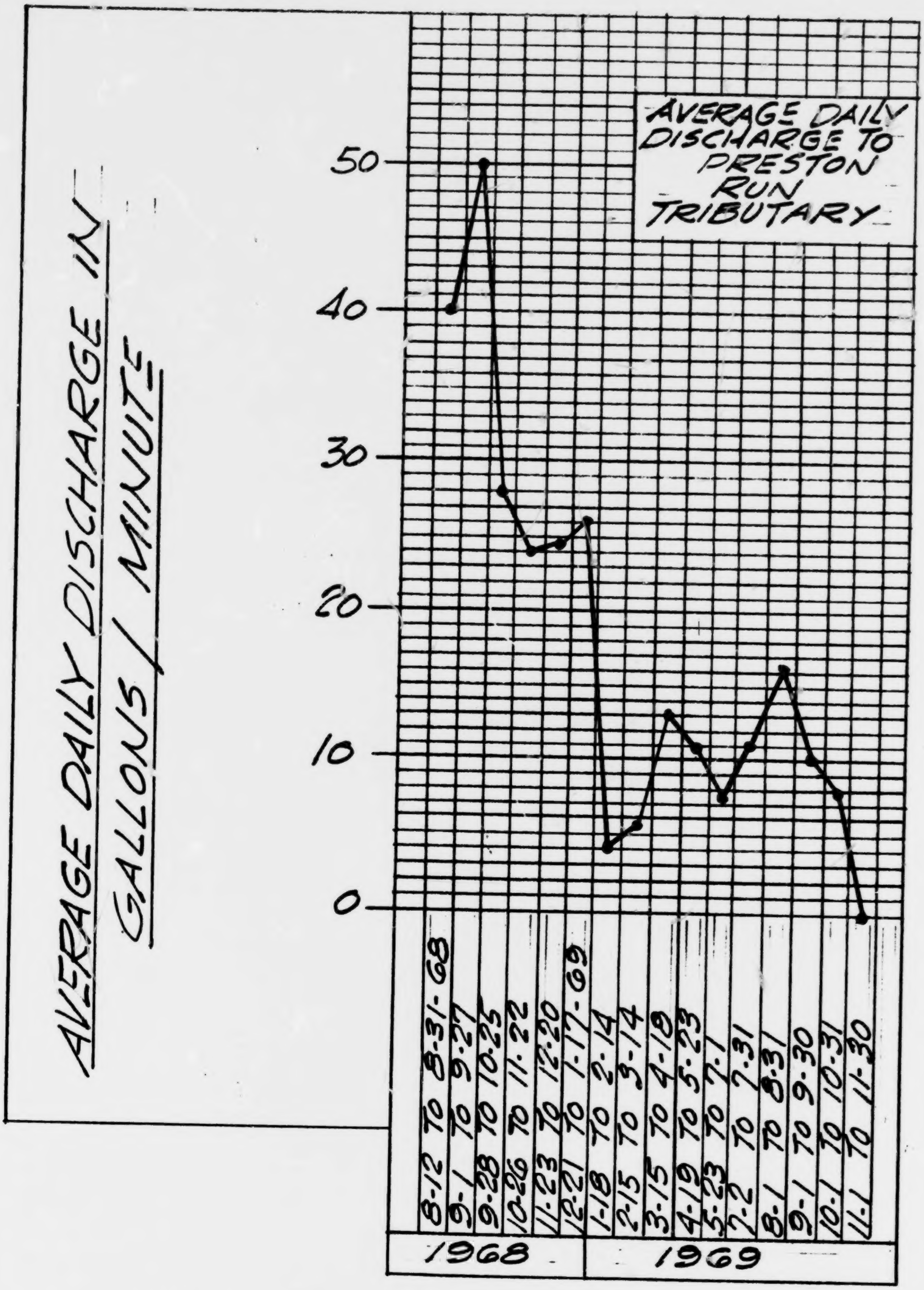

FIGURE 25 - AVERAGE DAILY DISCHARGE - GALLONS/MINUTE

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VII

EVALUATION AND DISCUSSION

Several aspects of the operating period warrant special comment. Discussion follows:

Suspended Solids Removal.

Records of solids removed by the scrap pump, primary filters, diatomite filters and cartridge filters were not kept. However, from analysis of weekly samples, it is possible to calculate the solids removed by the primary and secondary (diatomite) filters. Referring to Table A-4 "Quality of Recirculated Water" it is possible to obtain the average of twelve weekly samples for the quarter ending October 1969. These values of suspended solids are:

	Primary Filter West	Diatomite Filters
Entering ppm	3870	73
Leaving ppm	73	4.7
Difference ppm	3797	68.3
Flow - from Table 16 - GPM	52.4	52.4
*Solids Removed - lbs/day	2400	43.0

Primary Filter - Weight of Solids =

$$\frac{3797 \text{ ppm} \times 52.4 \text{ GPM} \times 1440 \text{ min.} \times 8.34\#/\text{gal}}{1,000,000} \cong 2400 \text{ lbs}$$

Diatomite Filter - Weight of Solids =

$$\frac{68.3 \times 52.4 \times 1440 \times 8.34}{1,000,000} \cong 43.0 \text{ lbs.}$$

*As noted above, scrap pump solids removal data were not taken. However, from general observation, the scrap pump solids removal appears to be approximately the same as that from the primary filters. Stated another way, about 4800# of solids are removed ahead of the diatomite filters which remove 43.0 additional lbs. each day.

Diatomite Filter Performance.

The latest month, November 1969, for which data is available had insignificant interruptions. From Table 1 the percentage of "on-stream" time was 94.0.

Diatomite used is calculated as follows:

$$75\#/\text{charge} \times 2 \text{ charges/day} \times 30 \text{ days} \times 94\% = 4200\#$$

Water Filtered:

#2 Meter (Filtered Water plus make-up) recorded 2,915,300 gals. in Nov.
#5 Meter (Make-up to clean water tank) recorded 618,700 gals. in Nov.
Water re-circulated (filtered) = #2-#5 meters = 2,296,600 gals. in Nov.

Water Filtered per lb. of Filter Aid:

$$= \frac{2{,}296{,}000 \text{ gallons} \times 94\%}{4{,}200\# \text{ Diatomite}} = 513 \text{ gallons/lb.}$$

Solids removed in November:

	Entering Suspended Solids PPM		Leaving Suspended Solids PPM
November 6, 1969	96		8
November 13, 1969	96		5
November 20, 1969	32		2
November 26, 1969	136		1
Total	360		16
Average	90		4
Difference . . .		86	

Weight Removed =

$$\frac{2{,}296{,}600 \text{ gals} \times 94\% \times 8.34\#/\text{gal} \times 86 \text{ ppm}}{1{,}000{,}000} = 1540 \text{ lbs.}$$

$$\text{Ratio Solids Removed to Filter Aid} = \frac{1540\#}{4200\#} = .367$$

$$\text{Ratio Solids Removed to Cake} = \frac{1540}{1540 + 4200} = .268$$

TABLE 1

ON-STREAM CYCLE LIFE

WPRD 87-01-68

Date	Filter "A"	Filter "B"	Date	Filter "A"	Filter "B"
10/8/69	12 hours	10 hours	11/1/69	12 hours	12 hours
10/9	10	12	11/2	12	12
10/10	-	12	11/3	12	12
10/11	12	11.5	11/4	11.5	12
10/12	3.5	14	11/5	12	12
10/13	12	12	11/6	11	7.5
10/14	12	12	11/7	12	10
10/15	12	2	11/8	12	12
10/16	24	- *	11/9	12	12
10/17	9	-	11/10	12	8
10/18	16	-	11/11	12	12
10/19	12	-	11/12	12	12
10/20	20	-	11/13	11	10.5
10/21	19	-	11/14	8.5	11.5
10/22	24	-	11/15	10.5	12
10/23	23	-	11/16	12	12
10/24	20	-	11/17	12	12
10/25	16	-	11/18	12	8
10/26	22	-	11/19	12	12
10/27	11.5	-	11/20	12	10.5
10/28**	-	-	11/21	12	11
10/29	12	12	11/22	12	9.5
10/30	12	12	11/23	9.5	12
10/31	12	12	11/24	12	12
			11/25	12	12
			11/26	12	12
			11/27	12	12
			11/28	-	12
			11/29	12	12
			11/30	12	12
			Total	338.0 +	338.5 = 676.5

Actual Hours November 30 x 24 = 720

Percentage "on-stream" - 94.0

* Mechanical seal on "B" Filter pump failed

** On city water

TABLE 1 - ON-STREAM CYCLE LIFE

Check.

A sample of filter cake taken June 4, 1969 was submitted for chemical and petrographic analysis. The probable composition was reported as follows:

Diatomite	72 to 75%
Glass Fiber	20
Quartz	Less than 5
Resin	2.6
Calcium Carbonate	.2

The June sample analysis corroborates the November performance calculated above in which diatomite is $\frac{4200\#}{1540 + 4200\#}$ - or 73% of the cake content

Cost of Filtered Water.

Table 2 provides an approximate cost for operating the filters by adding the + items, except for the salt used in the softener, which is required regardless of the needs of the closed water system.

	Gross	Net
Operating costs for November, 1969 add to	$2,556	$ - 154
Depreciation - $\frac{\$12,100}{12 \text{ mos.}}$ -	1,008	1,008
Total cost	$3,564	$ 854
Water re-circulated = 2,296,600 gallons		
Cost per 1000 gallons =	$1.56	$ .37

Cost of City Water.

City of Defiance billing for November 1969 was $604.22 for 956,700 gallons, or $.63 per 1000 gallons. To that is added the cost of softening which amounted to $81 in November ($40.50 for salt, and $40.50 for labor) for softening 618,700 gallons of process make-up water and 44,520 gallons of boiler feed.

Softening cost was $\frac{\$81}{663{,}000 \text{ gallons}}$ - - or $.12 per 1000 gallons

Capital cost of softening equipment not included - considered negligible.

The cost of City Water for process use is therefore $.63 + .12 - or $.75 per 1000 gallons.

Comparison City Water -vs- Filtered Water Costs.

As outlined above, the gross cost of filtered water is $1.56 per 1000 gallons, while the current cost of city water softened for process use is calculated at $.75/1000 gallons. The question might be raised as to why the expensive process of cleaning up dirty water for reuse is practical when new water costs half as much. The answer to this question is that use of 100% fresh water would not have solved the waste discharge problem. Further, operation on an open basis would just about double the water requirement again, so that the total cost of water would, in effect, be double that paid under the re-circulating system. Water costs would be approximately what was paid to the City in the last six months of 1968 (Refer to Table 12). In another view, the net cost of filtered water is $.37 per 1000 gallons -vs- $.75 for softened City water.

Water Re-use.

From Table 16 it is seen that during the quarter ending October 31st, 1969, an average re-circulation volume of 52.4 gallon/minute was metered, while at the same time, 15.2 gallon/minute of fresh water was admitted to the system. In order for the 15.2 GPM to do the work accomplished by 52.4 x 15.2 GPM, it has to be used several times - in fact - $\frac{67.6\ \text{GPM}}{15.2\ \text{"}}$ - or 4.5 times.

It is possible that it could be re-circulated more times, with the limiting factor eventually being the tolerable limit of dissolved solids concentration. The rate of re-use in this system is determined by the amount of evaporation, a process variable, which in recent history, has not changed significantly.

WATER BILLS - CITY OF DEFIANCE
WPRD 87-01-68

	Meter Readings		Cubic Feet	Water
	Present	Previous	Used	Charge
June 25, 1968	751,800	327,100	424,700	$1,438.10
July 26, 1968	1,168,100	751,800	416,300	1,414.54
August 22, 1968	535,400	168,100	367,300	1,277.38
September 26, 1968	985,000	535,400	449,600	1,507.82
October 23, 1968	2,313,700	1,985,000	328,700	1,169.30
November 20, 1968	623,500	313,700	309,800	1,116.38
December 26, 1968	3,065,200	2,623,500	441,700	1,485.70

January 27, 1969	336,200	065,200	271,000	1,007.74
February 24, 1969	472,300	336,200	136,100	630.02
March 25, 1969	704,200	472,300	231,900	898.26
April 23, 1969	986,800	704,200	282,600	1,040.22*
May 27, 1969	4,186,200	3,986,800	199,400	807.26*
June 24, 1969	319,800	186,200	133,600	623.02
July 20, 1969	493,000	319,800	173,200	733.90
August 22, 1969	624,900	493,000	131,900	618.26
September 24, 1969	776,000	624,900	151,100	670.02
October 24, 1969	905,600	776,000	129,600	609.82
November 21, 1969	5,033,200	4,905,600	127,600	604.22

* High consumption due to fungus

TABLE 12 - WATER BILLS, CITY OF DEFIANCE

Operation and Maintenance Activities.

Grant application estimates totalling $9,560 were exceeded by $14,622 for twelve months ending January 15, 1970. Cost elements considered in the application are compared as follows with actual expenditures:

	Grant	* Actual
Labor	$3,200	$13,351
Diatomaceous Earth	2,080	2,954
Ammonia	630	2,241
Power	3,650	4,704
Sub-total	$9,560	$23,250
Other items not considered are:		
Fiber Glass Filters		436
Polypropylene Media		1,291
Fungicide and Dispersant		1,908
Total	$9,560	$26,885

Production Changes Affect Data Use.

Production operations for January through July of 1969 were substantially unchanged from the six month period before closed system operation, except for the inclusion of the closed water system. Any effects noted could be attributed to the closed water system. In August, however, another change occurred in the form of a different method of binder application. There being no other changes in operation or in the closed water system, effects noted are attributable to the changed method of applying binder.

Operating Cost Differences.

The most notable effect was the immediate loss of binder savings which had been increasing since the inception of the closed water system. Savings recurred in September and although much smaller than in the months prior to August, subsequent results show that the savings are still increasing. Accordingly, it is believed that data relating to savings should be viewed in the light of the first seven month's performance. Savings are therefore discussed from records of the first seven months.

* From Table 2, a table of differences in operating costs adjusted for volume. It will not agree with actual $24,182 reported in Table #17, (period 1/15/69 - 1/15/70).

Operating Cost Differences.

Operating costs are not reported per se but differences in operating costs incurred during a base period prior to the installation of the closed system and costs developed during the operation of the closed system are reported. Under this approach a lower operating cost than those incurred in the base period are given a negative sign which represents a saving. Higher costs than those incurred in the base period receive a plus sign which represents increased cost to operate the system. Table 2 shows how the significant elements of cost have developed during the twelve months of operation. Discussion of these cost factors is covered later in this section.

Water Consumption and Quality.

Water consumption and quality is not believed to have been affected by the change in binder application which was initiated in August. There is therefore no reason for limiting the data gathered for this phase of the study. All data taken will be used in the discussion of water quantity and quality.

Data Frequency.

Data were taken as noted below:

Before Closed System Operation:

Daily.

Water meter readings to the plant and distribution readings within the plant were taken daily. Flow readings at #1 and #2 Discharge Weirs were made once each day. The weir readings represent momentary rates of flow, while the meter readings produce total flows for the twenty-four hour day. Daily usage of salt for water softening was noted. The complete record of these daily flows is submitted herein. (Refer to Table A-1).

Weekly.

Grab samples of water were taken from #1 and #2 Discharge Weirs and upstream and downstream of these discharges and analyses of the samples were made for Biological Oxygen Demand - 5 day, Dissolved Oxygen, pH, Phenol, Suspended Solids and Total Solids once a week for the month of December 1968. These data are enclosed herein in Table 4.

WATER QUALITY - DISCHARGE - 1968

WPRD 87-01-68

Sample	Location	5 Day B.O.D. PPM	Dissolved Oxygen PPM	pH	Phenol PPM	Total Solids PPM	Susp. Solids PPM	Flow - GPM
12/5/68								
#1	Upstream	38	4.9	7.5	.010	465	77	-
2	Downstream	68	4.4	8.9	3.000	7648	72	-
3	#1 Weir	27	5.1	8.9	3.360	1117	122	21.7
4	#2 Weir	61	3.7	8.2	.243	4081	23	
12/12/68								
#1	Upstream	21	5.2	7.7	.014	507	83	
2	Downstream	62	4.1	6.5	3.860	1139	34	
3	#1 Weir	22	5.1	7.8	3.100	881	84	Plugged Sewer
4	#2 Weir	70	5.6	8.4	0.228	477	67	Plugged Sewer
12/20/68								
#1	Upstream	20	5.0	7.0	.002	39	17	
2	Downstream	17	4.2	7.9	3.040	506	19	
3	#1 Weir	26	5.3	7.9	4.720	562	56	27.6
4	#2 Weir	12	6.1	7.6	.069	193	07	1.0
12/26/68								
#1	Upstream	44	4.7	7.4	.003	1430	585	
2	Downstream	20	5.8	7.8	2.520	1300	34	
3	#1 Weir	18	5.9	7.7	4.240	1014	50	21.7
4	#2 Weir	13	4.2	7.2	.090	857	35	

TABLE 4 - WATER QUALITY - DISCHARGE - 1968

After Closed System Operation:

Daily.

Water meter readings to the plant and distribution readings within the plant were continued on a daily basis as before operation of the closed water system. Necessarily certain meters in the distribution system were relocated because of piping changes in the closed system. Readings of flow at #1 and #2 Discharge were continued on a once-daily basis. Daily usage of salt for water softening was noted. The complete record of these logged daily flows is submitted herein. (Refer to Table A-2.)

Weekly.

Grab samples were taken from #1 and #2 discharge weirs and from upstream * and downstream of the weir discharges and analyzed once a week. Grab samples were also taken from the circulated "chain" cleaning water at entrance to primary filters, at entrance to secondary filters, at entrance to the filtered water tank and at entrance to the supply tank. All samples were analyzed for phenol, pH, suspended solids and total solids. (Refer to Table A-3 Water Quality Data - Discharge and to Table A-4 Water Quality Data - Recirculated Water.)

Other Discharges.

Other discharges not included in the scope of the grant will receive the following disposition:

Domestic Waste.

Domestic waste now being discharged to Preston Run tributary will, during early 1970, be connected to the Defiance Municipal Sewage Treatment Plant. A new 8" interceptor was laid in November in Hickory Street with terminus at Plant #3. The Johns-Manville connection will be made as soon as the Defiance Municipal Plant is ready to receive the added load.

Boiler Blow-Down.

Boiler "blow-down" now being discharged to Preston Run tributary will be connected to the new sanitary sewer line described above.

Softener "Backwash".

Softener "backwash" water now being discharged to holding tank and thence to Preston Run tributary will be connected to the new sanitary sewer line.

---

* Lack of flow upstream of the discharge point made it more desirable to shift this sampling point to the holding tank.

Mandrel Cleaning Water.

Mandrel cleaning water now being discharged to holding tank and thence to Preston Run tributary will be connected to the new sanitary sewer line.

Storm Water.

Storm water now being discharged from roof drains and grounds to Preston Run tributary will continue the present route without change.

Although the streams listed above were not considered as candidates for elimination in the grant application for WPRD 87-01-68, attempts to return mixed waters from the holding tank to "chain" cleaning duty were made, but proved unsuccessful because of severe foaming which resulted when the alkaline waters from the holding tank mixed with the "chain" cleaning water.

Preston Run Tributary.

When Plant #3 connects to the Defiance Municipal Sewage Treatment Plant in early 1970, the only water entering Preston Run tributary from Plant #3 will be storm water.

Effectiveness.

The closed system has demonstrated capability to carry out the objectives outlined in the grant application - namely to "eliminate completely the discharge of waste water from Johns-Manville Plant #3 at Defiance, Ohio. The water in question is used for cleaning chain conveyor belts in a fiber glass insulation plant and normally contains caustic and phenols in both dissolved and particulate form. This water is now discharged into Preston Run at an estimated rate of 30 to 50 gallons per minute. Preston Run flows into the Maumee River. The proposed system will remove glass and phenol particles and permits reuse of all process water other than lost by evaporation".

The project objective clearly states that the process waste to be eliminated is the water "used for cleaning chain conveyor belts". There is adequate evidence to show that the "chain" cleaning water discharge has been reduced to zero, but the practical test of seeing zero discharge is not possible until other discharges not included in the project scope are diverted to the Defiance Treatment Plant via a newly laid interceptor early in 1970. Reference is made to softener backwash and rinse water, to caustic mandrel cleaning water, to boiler blow-down water and to domestic waste from locker rooms and toilets. When these waters are connected into the Defiance system there will then be zero discharge over the weirs. The "paper" evidence that we now have zero discharge of "chain" cleaning process water follows.

Reduced Water Consumption.

Reference to Table 12 - Water Bills - City of Defiance - shows that consumption in the six months ending November 1969, amounts to 807,000 cubic feet (6,052,500 gallons) compared to 1,871,100 cubic feet (14,037,750 gallons) used in the last six months of 1968. In terms of average flow rate, 1969 usage was 23.2 gpm compared to 54.0 gpm in 1968. From meter data obtained in 1968, "non-process" water had the following values:

TABLE #13

"NON-PROCESS" WATER

	Softener Backwash, Boiler Feed and Cooling Tower		Locker Room and Quality Control
August	4.0 gpm		7.6 gpm
September	4.2		4.1
October	4.9		4.6
November	9.3		5.4
December	29.4 *		3.2
Total	22.4		24.9
Average	5.6	+	5.0 = 10.6 gpm

From the foregoing we can develop the following:

TABLE #14

"CHAIN" CLEANING WATER DISCHARGED - FROM WATER SUPPLIED

	1969 6 months ending November	1968 6 months ending December
Total Plant Consumption - gpm	23.2	54.0
Non-Process Water	10.6 (est.)	10.6 (metered 5 mos)
Process Water	12.6	43.4
Overspray and Binder use to evaporation	14.7	14.7 (est.)
"Chain cleaning water available for discharge	- 2.1	28.7

By calculation there was no "chain" cleaning water available for discharge in the six months ending November, 1969.

* This value not used.

A further judgment as to "chain" cleaning water discharged may be made by comparing Discharge Weir #1 and #2 flows for 1969 -vs- 1968. The weirs were set up in August, 1968, hence data is available from September, 1968.

TABLE #15

"CHAIN CLEANING WATER DISCHARGED - FROM WEIRS

	1969 #1 & #2 Weir	1968 #1 & #2 Weir
September gpm	10.1	50.2
October "	8.3	28.4
November "	.6 *	24.3
Total	18.4	102.9
Average gpm	9.2	34.3
"Non-Process" Water (from Table #13)	10.6	10.6
"Chain" Cleaning Water	- 1.4	23.7

By calculation there was no "chain" cleaning water in the discharge during the months examined above in 1969 as against 23.7 gpm in 1968.

Operating Costs.

Differences in operating costs are shown in Table #2. Each element of cost difference can be observed by reference to the table. The elements are discussed below.

Binder Solids.

Previous pilot plant experience on #5 Production Unit had indicated that significant savings in binder usage would be effected with the closed system. Savings developed from $1,433 in the first month to a maximum of $4,782 in the sixth month. In August, all production units used a new method of applying binder. Binder savings disappeared completely in August, recovering slowly in September with increasing gain for October and November. Apparently knowledge of ~~the~~ new method of binder application is gaining and savings may continue to grow to about the level attained in June. It is believed that the savings obtained for the seven months prior to the binder application method

* November, 1969, data not used due to practice of not recording all flows less than 1" crest.

change can be properly attributed to the closed system. This amounted to $21,002 for seven months operation = $3,000/month on the same basis as for the six months base period prior to operation of the closed system.

Water.

Water savings adjusted for production volume amounted to $5,696 for eleven months, or $518 per month. An approximate check on this saving can be obtained by comparing water bills before and after start of the closed water system. Water bills for seven months in the latter half of 1968 cost $9,406 or $1,344 per month. Water bills for eleven months of 1969 totalled $8,243 - or $749 per month. Average monthly saving was $595 computed on this basis.

A second method of checking water saved is to obtain the cost of the water recirculated. Water leaving the clean water tank is metered at #2 meter. Water entering the clean water tank is recirculated water from the diatomite filters plus fresh water make-up through #5 meter. Accordingly #2 meter - #5 meter = water recirculated. Using data from the most recent quarter ending October 31, 1969, we find: (See Table #16)

#2 meter - Average for 92 days - 67.6 gallons/minute
#5 meter - Average for 92 days - 15.2 gallons/minute
Water recirculated = #2 - #5 meter = 52.4 gallons/minute

Check - Water Recirculation Components

"Chain" cleaning water - 5 nozzles @ 5 gpm	= 25.0 gpm (spot check)
Dust Collector water- metered(1/17-2/30/69) (5 months 1968)	= 22.3 "
Primary Filter shower - estimate	= 3.0 "
Wash hoses - estimate	= 2.0 "
Compactor drainage - estimate	= 1.0 "
Unaccountable due to estimates and/or meter error	= 1.1
Total	52.4 gpm

Water saved = water recirculated = 52.4 gpm

$$\text{*Savings} = \frac{52.4 \text{ gpm x } 1440 \text{ minutes/day x } 30 \text{ days x } \$.46/1000 \text{ gals.}}{1000} = \$1{,}040/\text{month}$$

*Cost of water five month period 8/12 to 12/20/68 = $.46/1000 gallons.

TABLE #16

WATER USE SUMMARY

WPRD-87-01-68

(Average of Months 19, 20 & 21 - August, September & October 1969)

1. Flow Meter Data - 92 days.

		Filtered Water Plus Make-up #2 Meter (After clean water tank)	Binder Mix #3 Meter	Boiler Make-up #4 Meter	Make-up To clean Water Tank #5 Meter	Total City Water #1 Meter
Gallons/ Minute	#19	58.8	9.5	1.2	15.2	27.3
	20	66.0	10.0	.97	14.4	22.4
	21	78.0	10.0	1.2	15.9	24.2
Total		202.8	29.5	3.37	45.5	73.9
Average		67.6	9.8	1.1	15.2	24.6

2. Water Consumption.

Total consumption of city water averaged 24.6 gallons per minute.

3. Water Savings.

Water recirculated = water saved
#2 Meter - #5 Meter = water saved
67.6 gpm - 15.2 gpm - 52.4 gpm saved per minute

$$* \quad \frac{52.4 \times 1440 \times 92 \text{ days} \times \$.46/1000 \text{ gals.}}{1000} = \$3,190$$

A third check on water saved may be made by comparing Discharge Flows for September and October, 1968, with those for August, September and October, 1969. Average flow from #1 and #2 Weirs in two months was

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* Water cost of $.46 per 1000 gallons based on four month period August 12 to December 20, 1968.

39.0 gpm. For three months of 1969, flow from #1 and #2 Weirs averaged 11.5 gpm. An approximate saving of 27.5 gpm is indicated.

Saving:

$$\frac{27.5 \text{ gpm} \times 1440 \text{ min./day} \times 30 \text{ days} \times \$.46/1000 \text{ gals.}}{1000} = \$547/\text{month}$$

In review, we have monthly savings arrived at in different ways with different values, yet all are indicating that a saving did occur and that the magnitude ranged from $518 to $1,040, as follows:

Accounting method using standard costs - $518 (from Table #2)
Comparison of water bills - 595 (from Table #12)
Value of water recirculated - 1040
Comparison of water discharged to sewers - 547

Three methods of comparison agree quite closely, yet it is also true that the value of water recirculated is a perfectly valid figure. One has only to visualize a failure of filtering or other essential recirculating equipment to know that the water recirculated would have to be replaced with city water at a cost of approximately $1040 more each month.

Caustic Cleaner.

The cost of caustic cleaning compound has been reduced since it is no longer required for "chain" cleaning. Savings for twelve months totalled $1,307 equal to $109/month.

Salt.

The use of salt for water softening increased over base period requirements for the first six months of 1969. Trial production runs for the three week period, June 16th to July 7th, 1969 and from July 15th to July 17th, established the fact that soft water was necessary to prevent plugging of binder nozzles. Added information developed was that softeners needed regeneration only once in two days rather than daily. This reduced the backwash and rinse water quantities to half of the prevailing quantity prior to the trial and also reduced the amount of salt needed so that minor savings are being made here. Added salt costs of $125 in the first six months were offset by $16 of savings in the last five months ending in November. Net added cost for the eleven months was $109.

Diatomaceous Earth.

This element of cost is a definite requirement of the recirculating equipment. It represents added cost of $2,954 for the twelve month period = $246 per month. Reduction in the filter-aid cost is possible by limiting "on-stream" cycle life to a safe allowable pressure drop across the septa. "Pressure" control (as an alternate to "time" control) will produce maximum diatomite life but random cycle lengths will result, requiring regeneration attention at odd hours when maintenance personnel may be scarce. The time cycle life of twelve hours was set up to provide for day shift attention when maximum maintenance staff is available. Now that a year of experience has been attained, it is possible that night shift personnel can recharge the filters, thereby permitting maximum use of diatomite.

Anhydrous Ammonia.

Anhydrous Ammonia has been used for many years to stabilize binder mixture so that resin precipitation is prevented from taking place. It is well established that additional ammonia, but not scientifically determined how much more annonia, is needed to stabilize the "chain" cleaning water to prevent precipitation of resin solids which would adversely affect diatomite filtration. Accordingly, ammonia is admitted by manually controlled chemical feed pump to maintain a pH range of 8.5 - 9.5. This increased requirement cost $2,241 during the twelve month operating period, equal to $187 per month. Use of a pH controller is contemplated to determine if closer control is necessary. A lower pH range would cut ammonia costs and improve environmental conditions. A higher pH range will require ventilation control and additional funds to purchase the added ammonia required.

Maintenance Labor.

The largest element of cost in the operation is the amount needed for maintenance personnel to service all the equipment. Some part of this increased labor is required to obtain data required for this report - possibly an hour a day. Another source of improvement would be the mechanization of handling of the solids taken from the primary filter and from the scrap pump. The other work required, such as removing the cake, cleaning the septa and re-charging the diatomite filters, adjusting the primary filter media, unplugging scrap pump blockage, logging the state of the outside treating tank and many small tasks too numerous to mention here, are not apt to be profitable subjects for cost reduction. During the twelve months evaluation period, $13,351 have been expended for maintenance labor, or $1,110 per month. This is equivalent to an eight hour day for one man every day of the month. It is estimated that improvements and reduced data taking might lower this amount about 20%.

Fiberglass Cartridge Filter Tubes.

The expenditure results from replacing cartridges in the final or emergency filter at weekly intervals. It is possible that longer life might be obtained by a close study of the pressure drop across these cartridges. The increased cost is $36 per month average for the twelve month evaluation period.

Polypropylene Filter Cloth.

This cloth is used on the primary filters. A unique method of driving the cloth by frictional contact and slipping against the underlying moving support chain belt is believed to contribute to the rather short life of the cloth. More cycle life may be available by tying the medium solidly to the support conveyor to eliminate the sliding wear factor. Increased cost for this material for twelve months has run to $1,291 or $107 per month.

Fungicide Treatment.

A suitable fungicide and companion dispersant for removal of the killed fungus growths have been fed to the system since June 1969, after fungus growths blocked certain small diameter pipe lines. Increased cost for these chemicals amounts to $1,908 for eight months, or $239 per month.

Power Cost.

Recirculation requires added power to drive the pumps, screens and related equipment needed to re-use the water. Power consumption was not metered but was spot checked on September 18, 1969 with clamp-on-ammeter on the two feeders. Calculated loads amounted to 47.5 kw on the feeder to starter group "A" and 11.7 kw on the feeder to starter groups "B" and "C". A check reading with clamp-on kilowatt meter showed 50 kw as against 47.5 calculated, a variation of 5%. Total power consumption is thus found to be 47.5 + 11.7 or 59.2 kw. Since this power is incremental to the power normally used, incremental billing costs are used to determine the power cost as follows:

Demand - 59.2 kw				
	34 kw @ $2.00	=	$68	
	25.2 kw @ $2.35	=	59	
				$127
Energy				
	59.2 kw x 720 hrs			
	= 42,700 est. kwh.			
	42,700 kwh @ $.0064	=	$273	$273
Monthly estimated power cost				$400

This value has been used in Table #2.

Net Added Cost of Closed Water System.

Inspection of Table #2 shows a net reduction in operating cost of $10,364 for the first seven months of the evaluation period, prior to the time when a production method change temporarily reduced binder savings. Extrapolating this saving to an annual basis would create a net saving of about $17,000. The actual saving was $8,624 for twelve months. It is noteworthy that a recirculating system has not only fulfilled its assignment of eliminating process waste discharge, but has managed to do it at a saving in operating costs.

Capital Costs.

Table #17 compares actual expenditures with the amounts estimated in the grant application. In every category expenditure exceeded estimate.

Equipment and Materials.

This item represents the cost of equipment installed in place. When Engineering costs are added the total capital cost of the project is obtained - namely, $183,700. In general, equipment prices were in line with estimates, but bids for installation were higher than anticipated. Engineering in the application amounted to 9.2% of Equipment and Materials cost. For this type of project 20% would be more realistic, considering the fact that existing machinery had to be re-designed, and that engineering was needed on the preliminary and post-construction studies. Capital costs of $183,700 exceeded the estimated $150,038 by $33,662 - or 22%.

Technical Studies and Reports.

The requirements for sampling and laboratory analysis were not adequately recognized until after project approval and later discussion with the Project Officer. It is believed that the requirements are not excessive to protect the Federal investment. Nevertheless, the $1,557 estimated cost for studies was exceeded by $1,584 or 101%.

Total Project Cost.

Final figures now show that the estimated total grant application of $164,700 was exceeded by some 31% to a total expenditure of $215,633. Reference to Figure #8 will provide an idea of the cost status of the project at any time in the course of the project.

Financial Aspects.

Pollution control projects are not noteworthy for their financial desirability. All concerned are usually happy if the project accomplishes its purpose, whatever the cost. Even so, there are numerous opportunities for savings to develop, particularly when re-use of material, liquid, gas or solid, is involved.

CAPITAL COSTS

WPRD 87-01-68

	Grant Application	Total* Expended
A. Funds Required for Project		
1. Construction		
a. Contract No. 1 - Installation	$ 29,243	Incl.
b. Later Contracts		
c. Equipment and Materials	108,295	Incl.
Sub-total	137,538	$150,455
2. Technical Services		
a. Preliminary Studies and Reports	-	998
b. Engineering Plans & Specifications	12,500	33,245
c. Supervision of Construction	Incl.	Incl.
d. Post-construction Studies and Reports	1,557	3,131
Sub-total	14,057	37,374
3. Operation & Maintenance Activities	9,560	24,182
4. Legal and Fiscal	-	-
5. Administrative	3,545	4,620
6. Contingency	-	-
7. Other		-
8. Site	-	-
9. Total	$164,700	$215,633

* Amounts expended through January 15, 1970

TABLE 17 - CAPITAL COSTS

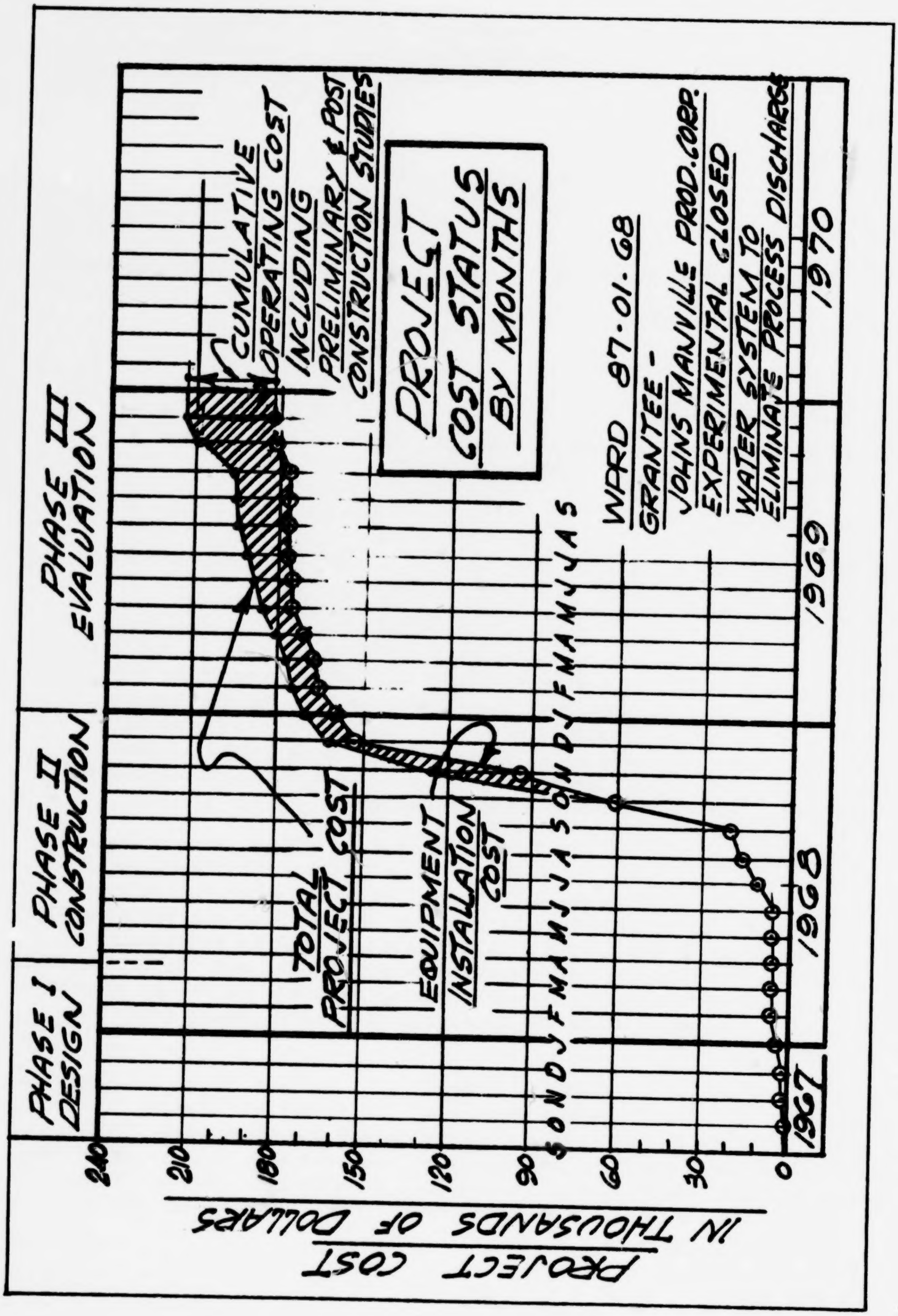

FIGURE 8 - PROJECT COST STATUS BY MONTHS

This project, fortunately, has elements of material saving, as discussed in several places. The net savings after deducting operating cost differences present an interesting return on the investment, as noted below:

Investment:

Equipment	$150,455
Engineering	33,245
	$183,700

Net savings (before taxes) $10,364 first seven months - $17,400 annually.

Return on initial investment $= \frac{\$17,400}{183,700} = 9.5\%$

Unexpected Problems.

Three problems developed which required prompt solution to avoid eventual interruption to service.

Septa Failure.

Early operation of the diatomite filters created dirty septa which became progressively more difficult to clean as time went on. The filters were fitted originally with septa of dacron material on an experimental basis. After one month of service, the vendor replaced the dacron septa with stainless steel septa on February 13th in "B" filter and February 21st in "A" filter. Three weeks later, on March 6th, it was necessary to take "B" filter out of service due to leaking diatomite and bulged septa believed due to excessive differential pressure. New stainless steel septa were replaced March 11, 1969. The failed tubes were coated with a thin brown coating easily removed with high pressure water (when not in filter).

Various methods were tried to clean the tubes, the basic routine being a hosing operation from below the tubes using 50 psi filtered water after blow-down and occasionally 200 psi filtered water. On a few occasions a caustic cleaning solution was charged into the filter shell and kept at about 150 deg. F with live steam for about eight hours. Noticeable cleaning was effected with caustic baths, but the time element did not warrant this as a routine cleaning method. The result of resin buildup on the septa tubes was inability to achieve twelve hour "on-stream" cycle life.

When the differential pressure - "delta p" - reached 18 psi the pressure switch in the control system would take the filter off stream. On one occasion in the second month of operation and the third week of stainless steel septa service, the "delta p" exceeded safe values before the standby filter could be put "on-stream", resulting in failure to two thirds of the septa near the tube sheet. Some filter outage occurred until the tubes were replaced. To improve this condition, the programmed "re-precoat" cycling which was operating at 45 minute intervals was adjusted so that no supplementary precoat phases occurred during the twelve hour "on-stream" cycle. A change in the diatomite feed procedure accompanied the change in precoat cycles. Previously the full 75# charge was placed in the removable pot at the bottom of the filter shell from which it was precoated to the septa, then served as filter-aid for 45 minutes, was next taken off stream and "bumped" until precoat and dirt were deposited in the pot, then re-precoated (including dirt) and returned to "on-stream" filtering duty for another 45 minute cycle. The revised procedure calls for 25# of initial precoat in the pot, the remaining 50# to be "body fed" over the twelve hour "on-stream" cycle.

"Body-feed" is accomplished by means of a dry feeder which meters filter-aid into a vortex mixing pot and by venturi action discharges the mix into the dirty water tank from which it builds up gradually on the septa. The reasoning behind this change was to avoid exposure of bare septa surface to the resin bearing water and suspended resin in the re-precoating phases and so reduce the possibility of resin "plating" out on the septa. "Body Feed" was adopted on April 17th and has been effective in maintaining twelve hour "on-stream" cycles since that time. It is noted at the same time that there have been numerous occasions since "body feed" was introduced when short cycling has occurred. In most such cases recovery to normal cycles occurred after re-charge and the cause of the short cycle was attributed to a shock peak load. A log of "on-stream" cycle life has been maintained since October 8th. Table #1 shows the "on-stream" hours for each filter each day. It can be seen that for the month of November a 94% duty was achieved.

One additional step has been taken to prevent excessive "delta p" from occurring. The pressure switch which formerly took the filter off stream in the event of excess pressure, removed the excess pressure only after the stand-by filter was ready to come on-stream. If the stand-by filter was not in a "ready" state to come "on-stream", the excess pressure would not be relieved,until the change was made which immediately takes the filter off-stream and transfers it to "blow-down" phase when the pressure switch sees high pressure. It is believed that these steps make the septa less vulnerable to failure.

Foaming.

Several attempts to return water from the out-of-doors treatment tank back to process resulted in foam, even though aeration spray action in the outside tank did not generate foam. One explanation is that the high pH water in the outside tank combined with ammonia in the circulating system to form an amine, which is a type of foaming agent frequently used in soap manufacture.

Attempts to reduce foam by use of a silicone de-foaming agent reduced foam but also served to "blind" up the diatomaceous earth filters. Foam generation resulted in faulty float level control in the dirty water tank, which, in turn, due to low suction head on the supply pumps to the Diatomite filters, caused air to be passed through the filters with increased pressure drop across the septa. These pressure drops returned to normal values as soon as the liquid level in the dirty water tank was restored. Added difficulty caused by the foam was the problem of operation when the floor in the water room was covered with 4" of foam.

Plans were made to reduce the flow of water to the outside treatment tank to the point where it could be evaporated by the aerator. Action taken to reduce softener backwash water discharge to the open tank was a thirty day trial production operation with unsoftened water. Results were not conclusive enough to warrant operation with unsoftened water. An incidental benefit was the discovery that the softeners need be regenerated once every two days, rather than daily, thereby reducing softener backwash by half. Plans to heat the caustic mandrel wash tank with gas, rather than steam, and so reduce the tank overflow, were considered, but held in abeyance pending the extension of an interceptor from the City of Defiance treatment plant to Plant #3. The interceptor was laid in November but cannot be connected to until early 1970 when the city treatment plant can accept the plant domestic and alkaline waste.

Another approach considered was to reduce the ammonia concentration in the circulating water. A probable effect of such an approach would be some de-stabilization of the resinous "chain" cleaning water and consequent rapid "blinding" of the diatomite filters. Foaming was not conquered during this project. Its occurrence and bad effects resulted from a desire to eliminate all Plant #3 discharge possible, which, however was incidental to the main purpose of the project - elimination of "chain" cleaning discharge.

Fungus.

During the week prior to April 18th, a gray rubber-like non-sticky slime became evident in open ends of piping and on April 18th a one-half inch pipe line which supplied the cleaning shower on the West Primary filter became inoperative because of complete plugging with slime. This incident caused a decision to stop recirculation until more knowledge was available as to the extent of slime deposits in lines and a proper course as to the removal. Recirculation was stopped on April 18, 1969. Water treatment specialists were consulted on April 19th and a tentative program established for treatment beginning April 21st. Treatment for the ensuing week consisted in recirculating water treated with a bis-thiocyanate for two days through the "chain" cleaning portion of the circuit, while supplying binder and overspray requirements from city water; and a similar treatment operation of twenty-six hours using sodium hypochlorite. Neither of these treatments was effective in removing the slime.

Accordingly, a full scale investigation was mounted by consultants. The microbiological growth was identified as a fungus. Normal water circulation was resumed on April 30th, with expectation that fungus would re-appear. Fungus did re-appear and was sufficiently developed by May 22nd to warrant treatment. A fungicide was applied on May 29th which was compatible with binder ingredients so that no adverse effect would accrue to the fiber glass product. A dispersant was simultaneously fed to distribute the fungus as it dies and falls away from pipe and tank walls. Monthly reports from consultants indicate that fungus growth is being contained. Treatment has been reduced but is maintained on a continuous basis. As further experience is gained, other approaches such as intermittent shock treatment or treatment of make-up only will be taken if present methods should fail to be effective.

Discharge to Preston Run.

A comparison is made of the pollution elements discharged before and after closed system operation.

In Table #4 - Water Quality Discharge 1968, the discharge to the stream is reported for the period prior to system operation.

TABLE #5 - WATER QUALITY DISCHARGE 1968 - POUNDS/DAY

1968	Location	pH	Phenol P.P.M.	Suspended Solids P.P.M.	Total Solids P.P.M.	Dissolved Solids P.P.M.	Flow GPM
12/5	#1 Weir	8.9	3.360	122	1117	995	21.7
12/20	"	7.9	4.720	56	562	506	27.6
12/26	"	7.7	4.240	50	1014	964	21.7
Total #1 Weir			12.320	228		2465	71.0
Average #1 Weir		7.7-8.9	4.11	76		822	23.7
Lbs/day			1.17	22		234	
12/20	#2 Weir	7.6	.069	7	193	186	1.0
Lbs/day	"		.00083	.08		2.2	
Total lbs/day #1 & #2 Weirs			1.17083	22.08		236.2	

In Table #6 the quality of water discharged after closed system operation was achieved, is reported. In Table #7, the quality is shown as pounds per day.

TABLE #7 - WATER QUALITY DISCHARGE 1969 - POUNDS/DAY

1969	Location	pH	Phenol P.P.M.	Suspended Solids P.P.M.	Total Solids P.P.M.	Dissolved Solids P.P.M.	Flow GPM
7/3	#1 Weir	7.2	2.3	38	1033	995	2.2
7/10	#1 Weir	7.9	10.4	48	1026	978	6.0
7/17	#1 Weir	7.0	.02	24	627	603	6.0
Total #1 Weir . . .			12.72	110		2576	14.2
Average #1 Weir		7.0-7.9	4.24	37		857	4.7
Lbs/day #1 Weir			.239	2.1		48.5	
7/3	#2 Weir	7.1	.17	1	1135	1134	8.9
7/10	#2 Weir	8.8	.03	39	495	456	12.4
7/17	#2 Weir	8.3	.01	11	363	352	6.0
Total #2 Weir . . .			.21	51		1942	27.3
Average #2 Weir		7.1-8.8	.07	17		647	9.1
Lbs/day #2 Weir			.007	1.8		71	
Total lbs/day #1 and #2 Weir			.246	3.9		119.5	

In summary, December 1968 discharges averaged 1.17083 lbs. phenol per day, compared to .246 lbs/day in July 1969. Similarly, 1968 suspended solids discharged was 22.08 lbs/day -vs- 3.9 lbs/day in 1969. 1968 dissolved solids amounted to 236.2 lbs/day, while 1969 dissolved solids totalled 119.5 lbs/day. pH ranges were comparable for both periods. On every count, therefore, pollutants discharged were greatly reduced after the closed water system went into service. Phenol discharged in July 1969 amounted to one-fifth of December 1968 discharge. Suspended solids were also only one-sixth of the December 1968 discharge, while dissolved solids were cut in half.

TABLE 6

WATER QUALITY - DISCHARGE - 1969
WPRD 87-01-68

Location	Sample	Phenol PPM	pH	Suspended Solids PPM	Total Solids PPM	Flow GPM
Sample taken 7/3/69						
Weir #1	#3	2.3	7.2	38	1033	2.2
Weir #2	4	.17	7.1	1	1135	8.9
Outside tank	1	11.2	12.2	44	6912	
Downstream of Discharge	2	.10	8.0	0	768	
Sample taken 7/10/69						
Weir #1	#3	10.4	7.9	48	1026	6.0
Weir #2	4	.03	8.8	39	495	12.4
Outside tank	1	22.3	11.9	167	11,391	
Downstream of Discharge	2	1.6	9.2	10	707	
Sample taken 7/17/69						
Weir #1	#3	.02	7.0	24	627	6.0
Weir #2	4	.01	8.3	11	363	6.0
Outside tank	1	10.4	11.6	110	5440	
Downstream of Discharge	2	.01	7.6	16	491	
Sample taken 7/24/69						
Weir #1	#3	.03	7.9	12	725	- *
Weir #2	4	.02	7.5	38	450	- *
Outside tank	1	48.7	10.0	55	6659	
Downstream of Discharge	2	.01	7.9	110	493	

* Flow measurements not taken this date

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VIII

RECOMMENDATIONS

Future Studies.

Certain aspects of the recirculating operation could be better understood than present knowledge permits. For this reason additional studies are suggested:

pH range.

Ammonia is used to stabilize the solubility of phenolic resin in the water solution. More detailed knowledge is needed to establish if higher ammonia concentrations increase stability of the resin and thereby reduce the phenolic resin suspended solids load in the diatomite filters. Correlation between dissolved phenolic resin concentration and pH values could determine optimum values of pH for best filtering conditions. Laboratory studies supplemented by field tests on filters should be able to pin point the desired control point.

Chain Cleaning Pressures.

Studies are desirable to determine the ideal nozzle shape and nozzle pressure for maximum chain cleaning effect. The combination now in service works well, but lower pressures and other nozzles might produce equal cleaning at a lower investment cost.

Future Operational Changes.

Experience obtained at Defiance 003 has permitted Johns-Manville to install a comparable re-circulating system at its Winder, Georgia Fiberglass Plant, which went into service in September of 1969. Among the changes made are:

Scrap Pump Deleted.

This specially designed piece of dewatering equipment was not considered essential to the operation. A scrap pump was not included at Winder, but it must be admitted that the fiber which it would have removed if installed, has to be removed on the primary screens, thereby increasing the duty on them. A further feature of the scrap pump was its ability to remove large clumps of fiber and thus avoid possible blockage of pump suctions. It was established at Defiance 003 that such clumps could be cut up with a water jet at the pump inlet. The trench water

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centrifugal pumps at Winder are operating satisfactorily without benefit of scrap pump protection.

Primary Filter Screens.

The modified low bed filters used at Defiance 003 were adequate for the relatively mild loading placed upon them. However, in a large volume operation such as at Winder, reliability and rugged construction caused selection of flat vibrating screens to be made. In this instance the company has had several years of experience screening fiberglass from waste water, using flat vibrating screens. Again it is pointed out that the removal of a scalping stage (such as the scrap pump) places extra duty on the primary screens. Allowance for adequate sizing must be made here.

Winder, Georgia Operation.

The water recirculating system at Winder has been a successful extrapolation of the Defiance 003 demonstration project. Some diatomite septa failures have occurred, the flat screens do not handle as much water as intended with resulting heavier load to the diatomite filters. In general, however, the system is shaking down satisfactorily and promises to be successful. Conservation of water and resin are being achieved and discharge to stream does not occur.

Richmond, Indiana.

Expansion of fiberglass production at our Richmond, Indiana plant is now taking place. A recirculating system similar to the Defiance 003 system was installed in 1969. Details are somewhat different at this plant, which uses direct melt glass supply, as compared to melting pots at Defiance 003. The principles and major pieces of equipment are the same, however. The use of a different grade of resin and much higher peak loadings are creating diatomite filter problems which may require a greater degree of primary filtration.

General.

Pre-construction Study.

It is of utmost importance that the characteristics of the phenolic resinous water solution be accurately known, particularly for peak conditions, such as wash down periods, before specifying equipment for screening and filtration. Several stages of scalping and primary filtration may be required before the suspended solids are at a level for economical and practical diatomite filtration. Trial filtration tests are recommended, and such trials should be realistic, duplicating expected peak operating conditions as closely as possible. Such tests are not generally easily arranged and expedient trials are sometimes accepted which may turn out to be not representative of the actual conditions to be met. For this reason extra care is urged in obtaining basic data.

Post Construction Study.

Regular sampling, analysis and maintenance procedures are important to the economical operation of a recycling system if problems are to be corrected before they become large.

Potential Application To Other Plants and Other Industries.

Elimination of Waste Water Discharge.

Waste water from a fiber glass operation contains fibrous glass particulates, dissolved phenols, and partially polymerized phenol particles. Phenols are highly objectionable in potable streams because of taste and odor. The project has demonstrated zero discharge capability.

Reduction of Water Consumed.

Under our present system of chain cleaning, there is considerable water loss. With a closed system, the only water loss will be that evaporated during the product drying cycle. City water purchases have been substantially reduced.

Reduction of Phenolic Resin Usage.

The project has demonstrated that re-cycling of the chain cleaning water reduces the usage of phenolic resin sufficiently to provide significant savings. Similar systems will be proposed for installation at all Johns-Manville plants where a phenolic resin discharge occurs. Johns-Manville has a total of nine (9) such plants.

According to available information, our principal competitors in the fiber glass insulation business use a water soluble phenolic resin as a binder and have similar waste disposal problems. We estimate that there are approximately twenty-five (25) such fiber glass insulation plants. In addition, the same type of binder system is also used in the manufacture of mineral wool insulations. We estimate that there are approximately twenty (20) such plants, although many of these are smaller in capacity.

It is expected that a closed system which would conserve soluble phenolic resins and filter out phenolic particles from the effluent would be applicable in most industries which use either soluble phenolic binders or powdered phenolic binders as a saturant or impregnant. Such binders are often used in paper manufacture to produce strong water resistant papers. They are also used in the manufacture of electrical sheets, boards, and cut or molded parts. We do not have, however, direct information as to the methods used by these other industries in handling their phenolic wastes.

In summary, it is our opinion that the application of the proposed techniques in the fiber glass industry alone would have broad usefulness. If such techniques are also extended to the operations of other insulation manufacturers and of sheet and board manufacturers using the same type of binder, we would expect the process proposed to have still broader application.

METER LOCATIONS

Before Recirculation - 1968

#1 - Main Meter - City of Defiance

#2 - Overspray, Locker Rooms, Offices, Quality Control and Dust Collector, Oven Fire Line

#3 - Binder Mix

#4 - Overspray and Chain Cleaning

#5 - Overspray and Chain Cleaning

#6 - Dust Collector

#8 - Mandrel Cleaning

DAILY METER READING - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
003054	000002	000658	005430	000739	013570	114091			8/12			
003769	000002	000818	006590	000886	016923	114214			8/13			
004540	000003	000985	007802	001046	020472	114348			8/14			
005301	000003	001167	009005	001188	023959	114481			8/15			
006031	000004	001342	010127	001313	027379	114613			8/16			
006701	000004	001522	011285	001407	030947	114736			8/17			
007476	000005	001684	012629	001537	034708	114869			8/18			
008180	000006	001847	013917	001665	038212	114996			8/19			
008973	000008	002017	015316	001843	041591	115128			8/20			
009740	000010	002181	016647	001989	045066	115254			8/21			
010484	000011	002345	017919	002107	048626	115378			8/22			
011216	000052	002508	019139	002230	052139	115506			8/23			Filled Mandrel Cleaning tank
011937	000061	002672	020408	002365	055852	115629			8/24			
012631	000061	002830	021636	002478	059752	115751			8/25			
013393	000120	003001	022925	002614	063784	115883			8/26			Filled mandrel Cleaning tank Changed water hose
014079	000175	003167	023988	002715	067578	116003			8/27			
014710	000215	003328	024972	002794	071524	116117			8/28			
015347	000222	003487	026025	002880	075296	116229			8/29			
016012	000242	003657	027087	002991	078889	116347	3¼"	1"	8/30	41.8	2.2	
016754	000280	003832	028388	003156	082559	116482	3"	1"	8/31	34.2	2.2	
017488	000282	004010	029732	003301	086401	116619	3½"	1-3/4	9-1	50.3	8.9	
018852	000326	004351	031883	003581	093376	116865	3"	1-3/4	9-2	34.2	8.9	
No Data									9-3			

TABLE A-1 DAILY METER READINGS 8/12 - 9/3/68

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
019620	000366	004524	033113	003734	097113	116999	3¼"	1-3/4	9-4	41.8	8.9	
020393	000400	004686	034302	003890	100902	117136	3¼"	1-3/4	9-5	41.8	8.9	
021119	000460	004856	035418	004036	104608	117271	3¼"	1½"	9-6	41.8	6.1	
021819	000479	005034	036625	004156	108513	117401	3¼"	1"	9-7	41.8	2.2	
022521	000482	005212	037888	004285	112512	117534	3¼"	1"	9-8	41.8	2.2	
023214	000511	005393	039054	004387	116350	117665	3-3/4	1½"	9-9	59.7	6.1	
023893	000578	005562	040185	004496	119979	117785	3½"	1"	9-10	50.3	2.2	
024638	000598	005736	041468	004640	123865	117916	3½"	1½"	9-11	50.3	6.1	
025387	000612	005897	042735	004825	127547	118043	3½"	1-3/4	9-12	50.3	8.9	
026145	000635	006074	043954	005006	131171	118182	3¼"	1-3/4	9-13	41.8	8.9	
026920	000655	006258	045367	005200	134872	118318			9-14			
027671	000687	006435	046638	005389	138705	118452	3¼"	1¼"	9-15	41.8	3.8	
028421	000693	006610	047904	005532	142393	118582	3¼"	1-3/4	9-16	41.8	8.9	
029165	000728	006776	049219	005692	145858	118719	3"	1"	9-17	34.2	2.2	
029911	000754	006945	050451	005867	149560	118840	3¼"	3"	9-18	41.8	34.2	Raining
030657	000785	007112	051770	006035	153317	118968	3"	¼"	9-19	34.2		
031393	001012	007275	052972	006136	157247	119100	3-3/4	1½"	9-20	59.7	6.1	
032149	001035	007438	054184	006245	160955	119229			9-21			
032927	001056	007594	055434	006394	164487	119364			9-22			
033706	001127	007761	056637	006538	168044	119498	3-3/4	1½"	9-23	59.7	6.1	
034492	001146	007920	057858	006710	171593	119631	3"	1½"	9-24	34.2	6.1	
035199	001210	008100	058967	006874	175200	119756	3½"	1"	9-25	50.3	2.2	
035852	001228	008251	059960	007014	178758	119870	3"	3/8	9-26	34.2		
036583	001239	008427	061155	007188	182102	119997	3"	1½"	9-27	34.2	6.1	
037210	001240	008607	062193	007283	185654	120112	3"	½"	9-28	34.2		

TABLE A-1 DAILY METER READINGS 9/4 - 9/28/68

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
037940	001244	008792	063452	007442	189522	120245	3"	3/4"	9-29	34.2		
038686	001299	008965	064704	007639	192976	120379	3"	1½"	9-30	34.2	6.1	
039419	001317	009138	065896	007816	196286	120506	3½"	1½"	10-1	50.3	6.1	
040108	001340	009315	066985	007955	199679	120631	3"	1½"	10-2	34.2	6.1	
040774	001359	009485	067994	008108	202832	120748	3½"	1½"	10-3	50.3	6.1	
041438	001379	009670	069091	008267	206231	120870	3"	1"	10-4	34.2	2.2	
042080	001395	009862	070094	008423	209656	120992	3"	¼"	10-5	34.2		
042639	001416	010052	071157	008592	212892	121099			10-6			
043315	001444	010227	072087	008736	216835	121226	3"	1½"	10-7	34.2	6.1	Sewer Trouble
043881	001465	010399	072957	008832	220264	121331	1½"	1½"	10-8	6.1	6.1	Sewer Trouble
044484	001499	010599	073781	008943	223601	121448			10-9			Sewer Trouble
045096	001526	010769	074717	009084	226852	121559	2½"	1¼"	10-10	21.7	3.8	
045670	001535	010928	075735	009243	229446	121663	2"	1"	10-11	12.4	2.2	
046229	001546	011100	076652	009357	232556	121769	3"	0	10-12	34.2		
046743	001573	011280	077586	009478	235056	121870	2¼"	¼"	10-13	16.7		
047287	001595	011461	078488	009589	237371	121975	2½"	1"	10-14	21.7	2.2	
047907	001641	011634	079442	009700	240518	122089	1-3/4	1"	10-15	8.9	2.2	
048560	001659	011813	080523	009828	243581	122209	1¼"	3/4"	10-16	3.8		
049217	001679	011995	081549	009956	246754	122332	2½"	1½"	10-17	21.7	6.1	
049874	001707	012184	082683	010098	249864	122453	2½"	½"	10-18	21.7		
050494	001716	012370	083689	010234	253196	122568	3"	½"	10-19	34.2		
051134	001747	012551	084774	010385	256332	122691	2½"	0	10-20	21.7		
051766	001817	012730	085841	010562	259333	122813	2½"	0	10-21	21.7		
052403	001854	012688	086817	010720	262578	122928	2½"	½"	10-22	21.7		
053044	001881	013028	087819	010919	265628	123041	2½"	¼"	10-23	21.7		
053673	001909	013185	088840	011102	268532	123159	2½"	¼"	10-24	21.7		
054265	002021	013341	089721	011256	271210	123273	2½"	¼"	10-25	21.7		
054926	002059	013533	090844	011416	274180	123390	2½"	0	10-26	21.7		

TABLE A-1 DAILY METER READINGS 9/29 - 10/26/68

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
055550	002076	013709	091936	011561	277161	123516	3"	0	10-27	34.2	0	
056163	002089	013887	092983	011700	280090	123636	3"	¼"	10-28	34.2	0	
056759	002120	014065	093929	011838	282810	123756	2½"	0	10-29	21.7	0	
057369	002152	014242	094970	011971	285592	123870	2½"	3/4"	10-30	21.7	0	
057941	002178	014405	095887	012064	288414	123975	2½"	½"	10-31	21.7	0	
058550	002192	014596	096765	012153	291321	124095	2½"	3/4"	11-1	21.7	0	
059164	002204	014781	097745	012264	294247	121208	2½"	0	11-2	21.7	0	
059808	002205	014966	098763	012435	297272	124328	2½"	0	11-3	21.7	0	
060455	002230	015140	099752	012615	300088	124450	3"	1¼"	11-4	34.2	2.2	
061031	002260	015304	100534	012731	302940	124557	3¼"	1¼"	11-5	41.8	2.2	
061691	002290	015488	101475	012922	305718	124709	2½"	½"	11-6	21.7	0	
062300	002320	015652	102238	013093	308508	124819	2½"	1"	11-7	21.7	1.2	Raining
062891	002359	015828	103174	013261	311148	124934	2-3/4"	½"	11-8	27.5	0	
063464	002373	015999	104035	013390	313936	125039	2½"	¼"	11-9	21.7	0	
064073	002398	016171	104930	013542	316955	125151	2½"	¼"	11-10	21.7	0	
064722	002411	016342	105821	013716	320045	125271	2½"	0	11-11	21.7	0	
065323	002438	016495	106520	013888	322875	125381	2½"	0	11-12	21.7	0	
065863	002458	016646	107103	014002	325745	125483	2½"	½"	11-13	21.7	0	
066464	002502	016810	107746	014138	328650	125594	2½"	½"	11-14	21.7	0	
067081	002543	016983	108378	014261	331627	125710	2-3/4	1"	11-15	27.5	2.2	Raining 2 bags salt
067584	002576	017161	108970	014368	334732	125827	2-3/4	3/4	11-16	27.5	0	Raining 100 lb. salt
068092	002602	017341	109567	014470	337945	125942	2½"	0	11-17	21.7	0	200 lb. salt
068589	002621	017495	110120	014584	340939	126053	2½"	½"	11-18	21.7	0	200 lb. salt
069045	002735	017633	110516	014686	343762	126158	2"	0	11-19	12.4	0	200 lb. salt
069518	002766	017770	110970	014795	346636	126262	2½"	¼"	11-20	21.7	0	200 lb. salt
069946	002811	017906	111301	014868	349522	126361	2½"		11-21	21.7	0	200 lb. salt

TABLE A-1 DAILY METER READINGS 10/27 - 11/21/68

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
070308	002829	018036	111491	014875	352328	126470	2½"	½"	11-22	21.7	0	200 lb. salt
070659	002847	018187	111618	014879	355323	126587	2½"		11-23	21.7		300 lb. salt
071012	002877	018319	111726	014890	358431	126700	2½"		11-24	21.7		200 lb. salt
071365	002974	018466	111857	014894	361352	126817	2½"	1"	11-25	21.7	2.2	200 lb. salt
071709	003005	018602	112003	014900	368144	126927	2½"	3/4	11-26	21.7		200 lb. salt
072062	003021	018738	112158	014906	367165	127044	2½"	½"	11-27	21.7		200 lb. salt
072386	003043	018876	112282	014910	370047	127155	3	¼"	11-28	34.2		Raining
												200 lb. salt
072770	003055	019018	112422	014916	373329	127273	3"	¼"	11-29	34.2		200 lb. salt
073149	003066	019160	112559	014921	376697	127391	2½"	0	11-30	21.7		200 lb. salt
073517	003091	019304	112675	014928	379981	127511	2-3/4	0	12-1	27.6		200 lb. salt
073868	003107	019446	112768	014930	383103	127628	2½"	½"	12-2	21.7		200 lb. salt
074192	003136	019593	112779	014933	385980	127852	2½"	½"	12-3	21.7		200 lb. salt
074511	003166	019748	112791	014933	388808	127871	2½"	0	12-4	21.7		200 lb. salt
074861	003188	019899	112951	014960	391633	127993	2½"	0	12-5	21.7		200 lb. salt
075214	003288	020047	113054	014991	394431	128116	2-3/4	0	12-6	27.6		200 lb. salt
075563	003304	020204	113065	014995	397455	128242			12-7			200 lb. salt
075898	003312	020358	113072	014993	400383	128370	2½"	0	12-8	21.7		200 lb. salt
076241	003358	020486	113088	014994	403322	128490	2½"	0	12-9	21.7		200 lb. salt
076565	003398	020605	113119	014998	406044	128600	2½"	0	12-10	21.7		200 lb. salt
076932	003455	090735	113136	015000	409149	128722	2½"	0	12-11	21.7		200 lb. salt
077281	003495	020876	113161	015005	412143	128871			12-12			Plugged sewer
												200 lb. salt
077623	003506	021015	113218	015019	415013	129001	2½"	0	12-13	21.7		200 lb. salt
077968	003516	021154	113239	015023	418096	129134	3"	0	12-14	34.2		200 lb. salt
078313	003519	021301	113267	015028	421355	129271	2½"	0	12-15	21.7		200 lb. salt
078644	003565	021448	113281	015029	424358	129405	3"	0	12-16	34.2		Plugged sewer
												200 lb. salt

TABLE A-1 DAILY METER READINGS 11/22 - 12/16/68

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1968	Weir #1 GPM	Weir #2 GPM	Remarks
078917	003578	021593	113289	015030	426790	129527	2-3/4	0	12-17	27.6		200 lb. salt
079233	003509	021727	113325	015038	429548	129652	2-3/4	½"	12-18	27.6		200 lb. salt
079575	003598	021871	113355	015041	432511	129786	2-3/4	½"	12-19	27.6		200 lb. salt
079923	003602	022019	113407	015056	435475	129920	2-3/4	3/4	12-20	27.6		Raining
												200 lb. salt
080251	003609	022160	113434	015061	438459	130649	2-3/4	0	12-21	27.5		200 lb. salt
080287	003609	022306	113457	015063	441545	130184			12-22			200 lb. salt
080937	003670	022440	113498	015072	444590	130302	2½"	0	12-23	21.7		200 lb. salt
081271	003661	022588	113526	015075	447594	130428	2-3/4	0	12-24	27.5		200 lb. salt
081600	003682	022736	113541	015077	450646	130557	2½"	0	12-25	21.7		200 lb. salt
081943	003675	022877	113574	015085	453692	130679	2½"	0	12-26	21.7		200 lb. salt
082308	003721	023028	113591	015087	456614	130804	2½"	2"	12-27	21.7	12.4	Raining
												Switched sewer
												200 lb. salt
082697	003730	033170	113610	015081	459534	130937	2½"	2"	12-28	21.7	12.4	200 lb. salt
083071	003730	023312	113627	015094	462609	131079	2½"	2"	12-29	21.7	12.4	200 lb. salt
083435	003773	023445	113642	015097	465372	131215	2½"	2"	12-30	21.7	12.4	200 lb. salt
083828	003791	023592	113656	015099	468359	131358	2½"	2"	12-31	21.7	12.4	200 lb. salt

TABLE A-1 DAILY METER READINGS 12/17 - 12/31/68

METER LOCATIONS

After Recirculation - 1969

#1 - Main Meter - City of Defiance

#2 - After Cartridge Filters

#3 - Binder Mix

#4 - Boiler Make-Up and Cooling Tower

#5 - Upstream of Softeners

#6 - Dust Collector

#8 - Mandrel Cleaning

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
084196	003797	023727	113670	015101	471380	131498	2½"	2"	1-1	21.7	12.4	200 lb. salt
084577	003807	023841	113685	015103	474446	131624	2½"	2"	1-2	21.7	12.4	200 lb. salt
084939	003895	023986	113714	015109	477310	131727	2½"	2"	1-3	21.7	12.4	Switched sewer on Dust Collector
												200 lb. salt
085295	003928	024123	113749	015117	480121	131839	1½"	2½"	1-4	6.05	21.7	200 lb. salt
085680	003955	024270	113774	015131	483162	131945	1"	2½"	1-5	2.19	21.7	200 lb. salt
085975*	003962	024401	113795	015129	486051*	132055	1"	3"	1-6	2.19	34.2	Snowing
												200 lb. salt
086199	003970	024542	113806	015127	488771	132147	1½"	1"	1-7	6.05	2.19	Started Per filters 10:00 A.M.
												200 lb. salt
087041	003992	024678	113809	015129	492156	132194	1½"	0	1-8	6.05	0	200 lb. salt
087968	004005	024819	113812	015130	495757	132246	1½"	0	1-9	6.05	0	400 lb. salt
088901	004025	024964	113838*	015130*	499243	132297	1"	0	1-10	2.19	0	200 lb. salt
089668	004029	025104	113957	015417	502599	132363	1"	3"	1-11	2.2	34.2	Shut system off at 11:00 A.M. Back on city water
												200 lb. salt
089667	004054	025232	114107	015570	505516	132478	2"	3"	1-12	12.4	34.2	200 lb. salt
089666	004061	025375	114347	015789	508604	132614	1"	2½"	1-13	2.2	21.7	200 lb. salt
089850	004074	025568	114513	016046	511345	132734	1½"	1"	1-14	6.05	2.2	Started Per filter 10:00 A.M. 200 lb. salt

* Meters relocated

TABLE A-2 DAILY METER READINGS 1/1 - 1/14/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
090812	004098	025749	114679	016410	514118	132791	1½"	1"	1-15	6.05	2.2	200 lb. salt
091813	004106	025911	114866	016770	516938	132847			1-16			200 lb. salt
092756	004125	026080	115042	017103	519515	132900	2"	3"	1-17	12.4	34.2	Raining 200 lb. salt
093737	004229	026589	115251	017488	522280	132937			1-18			200 lb. salt
094610	004244	026431	115411	017849	524851	133009	1"	1"	1-19	2.2	2.2	200 lb. salt
095538	004299	026601	115576	018252	527550	133071	1½"	1"	1-20	6.1	2.2	200 lb. salt
096506	004316	026779	115779	018605	530283	133128	1-3/4	1"	1-21	8.9	2.2	200 lb. salt
097244	004322	026946	115975	018918	532767	133205	1½"	1"	1-22	6.1	2.2	On city water 4 hours 200 lb. salt
098179	004344	027113	116144	019245	535299	133261	1½"	1"	1-23	6.1	2.2	200 lb. salt
099136	004397	027298	116323	019578	537991	133328			1-24			Filled outside tank
									1-25			Plant down Gas curtailment
									1-26			Plant down Gas curtailment
099742	004483	027340	116472	019800	540383	133375	1½"	1"	1-27	6.1	2.2	200 lb. salt
100677	004490	027529	116685	020130	543116	133426	1½"	1"	1-28	6.1	2.2	Raining 200 lb. salt
101631	004499	027704	116905	020440	545938	133474	3½"	4"	1-29			Raining 200 lb. salt
102574	004530	027880	117098	020763	548561	133527	1"	1¼"	1-30	2.2	3.8	200 lb. salt
103511	004544	028055	117313	021025	551127	133570	½"	1"	1-31	0	2.2	200 lb. salt
104428	004565	028226	117493	021335	553625	133617	1½"	1"	2-1	6.1	2.2	200 lb. salt
105334	004580	028390	117681	021657	556078	133663	1½"	1"	2-2	6.1	2.2	200 lb. salt
106270	004590	028571	117873	021989	558524	133713	½"	0	2-3	0	0	200 lb. salt

TABLE A-2 DAILY METER READINGS 1/15 - 2/3/69

DAILY METER READINGS - WPRD 87-OI-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
107235	004644	028752	118087	022333	560996	133764	1"	0	2-4	2.2	0	200 lb. salt
108236	004680	028940	118307	022675	563647	133815	½"	0	2-5	0	0	200 lb. salt
109146	004827	029121	118480	022982	565648	133863	3/4	0	2-6	0	0	200 lb. salt
110093	004851	029306	118678	023313	568068	133913	3/4	0	2-7	0	0	200 lb. salt
111078	004869	029486	118884	023628	576657	133975	3/4	0	2-8	0	0	200 lb. salt
112087	004896	029658	119116	023953	573299	134021	3/4	½"	2-9	0	0	200 lb. salt
113056	004912	029816	119297	024256	575708	134067	3/4	½"	2-10	0	0	200 lb. salt
114042	004962	029988	119473	024564	578138	134116	3/4	0	2-11	0	0	200 lb. salt
115032	004977	030163	119699	024891	580592	134167	3/4	0	2-12	0	0	200 lb. salt
115958	005067	030337	119932	025186	583115	134247	3/4	0	2-13	0	0	200 lb. salt
116850	005118	030510	120145	025509	583862	134296	3/4	0	2-14	0	0	200 lb. salt
117750	005125	030689	120367	025837	583862	134345	3/4	0	2-15	0	0	200 lb. salt
118635	005125	030866	120587	026135	583862	134387	3/4	0	2-16	0	0	200 lb. salt
119484	005160	031035	120834	026422	583862	134431	3/4	0	2-17	0	0	200 lb. salt
120335	005179	031189	121017	026725	583862	134477	3/4	0	2-18	0	0	200 lb. salt
121226	005210	031363	121230	027029	583862	134524	3/4	0	2-19	0	0	200 lb. salt
122135	005221	031532	121443	027220	583862	134555	3/4	0	2-20	0	0	200 lb. salt
122982	005235	031690	121650	027513	583862	134600	3/4	0	2-21	0	0	200 lb. salt
123888	005236	031863	121900	027613	583862	134644	½"	½"	2-22	0	0	200 lb. salt
124789	005238	032035	122163	028099	583862	134688	3/4	0	2-23	0	0	200 lb. salt
125796	005255	032211	122417	028364	583862	134730	½"	½"	2-24	0	0	200 lb. salt
126759	005309	032378	122630	028554	583862	124761	½"	0	2-25	0	0	200 lb. salt
127646	005323	032535	122823	028825	583862	134802	3/4	0	2-26	0	0	200 lb. salt
128661	005343	032705	123021	029085	583862	134844	3/4	½"	2-27	0	0	200 lb. salt
129709	005352	032884	123245	029382	583862	134890	3/4	½"	2-28	0	0	200 lb. salt
130748	005367	033060	123458	029670	583862	134933	3/4	0	3-1	0	0	200 lb. salt
131880	005378	033246	123695	029967	583862	134982	3/4	0	3-2	0	0	200 lb. salt
132958	005408	033428	123918	030293	583862	135033	3/4	½"	3-3	0	0	200 lb. salt

TABLE A-2 DAILY METER READINGS 2/4 - 3/3/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
134058	005503	033604	124138	030591		135082	3/4	0	3-4	0	0	200 lb. salt
135125	005511	033774	124344	030836		135122	3/4	½"	3-5	0	0	200 lb. salt
135986	005539	033926	124535	031086		135180	3/4	2½"	3-6	0	21.7	System shut off, on city water at 10:00 A.M.
												100 lb. salt
136818	005555	034104	124727	031332		135328	3/4	2½"	3-7	0	21.7	200 lb. salt
137626	005573	034275	124928	031589		135471	3/4	2½"	3-8	0	21.7	200 lb. salt
138425	005588	034446	125125	031848		135615	3/4	2-3/4	3-9	0	27.5	200 lb. salt
139313	005617	034648	125348	032124		135776	3/4	2-3/4	3-10	0	27.5	200 lb. salt
140053	005629	034814	125552	032336		135912	1"	2"	3-11	2.2	12.4	Started Per filter at 3:00 P.M.
												200 lb. salt
140860	005640	034999	125762	032689		135998			3-12			200 lb. salt
141618	005692	035171	125957	033001		136084	½"	1"	3-13	0	2.2	200 lb. salt
142429	005708	035359	126170	033311		136172	½"	1½"	3-14	0	6.0	200 lb. salt
143333	005752*	035345	126368	033456		136262	3/4	1½"	3-15	0	6.0	Installed meter in return line from Pond
												200 lb. salt
144220	006049	035722	126588	033774		136352	3/4	1-3/4	3-16	0	8.9	200 lb. salt
145110	006468	035902	126821	034097		136439	3/4	1½"	3-17	0	6.0	200 lb. salt
145968	006779	036070	127036	034424		136526	3/4	3/4	3-18	0	0	200 lb. salt
146814	007134	036230	127254	034708		136603	3/4	1-3/4	3-19	0	8.9	200 lb. salt

* Meters relocated

TABLE A-2 DAILY METER READINGS 3/4 - 3/19/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
147680	007650	036401	127474	034966		136676	½"	1½"	3-20	0	6.0	200 lb. salt
148514	008253	036575	127671	035231		136750	1½"	1½"	3-21	6.0	6.0	200 lb. salt
149505	008859	036749	127853	035460		136825	1"	1½"	3-22	2.2	6.0	200 lb. salt
150418	009106	036917	128026	035640		136894	½"	1½"	3-23	0	6.0	200 lb. salt
151552	009106	037102	128234	035715		136985	2"	2"	3-24	12.4	12.4	Raining
152597	009144	087268	128445	035785		137061	1½"	3/4	3-25	6.0	0	200 lb. salt Returned water from Pond for 2 hrs.-Still foam
153593	009336	037447	128669	035921		137136	1½"	1½"	3-26	6.0	6.0	No salt Started returning water at 8:00 A.M.
154369	009929	037618	128867	036137		137205	1"	1"	3-27	2.2	2.2	200 lb. salt
155287	010345	037798	129067	036347		137283	1"	2¼"	3-28	2.2	16.7	200 lb. salt Stopped returning water from Pond at 8:00 A.M.
156485		037981	129257	036383		137374	1"	2¼"	3-29	2.2	16.7	200 lb. salt
157771	010343	038168	129439	036416		137480	½"	2"	3-30	0	12.4	200 lb. salt
No Data									3-31			200 lb. salt
160209		038503	129806	036483		137672	½"	1½"	4-1	0	6.0	
161470		038688	129997	036554		137782	3/4	1-3/4	4-2	0	8.9	200 lb. salt

TABLE A-2 DAILY METER READINGS 3/20 - 4/2/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
162566		038848	130170	036645		137879	3/4	2-3/4	4-3	0	27.5	
163401		039035	130393	036979		137977	3/4	1-3/4	4-4	0	8.9	200 lb. salt
							3/4	1-3/4	4-5	0	8.9	200 lb. salt
165001		039401	130850	037594		138164	3/4	1-3/4	4-6	0	8.9	200 lb. salt
165814		039581	131090	037927		138261	3/4	1-3/4	4-7	0	8.9	200 lb. salt
166602		039755	131298	038237		138354	3/4	2"	4-8	0	12.4	200 lb. salt
167391		039939	131521	038597		138457	3/4	2¼"	4-9	0	16.7	200 lb. salt
168143	010356	040112	131732	038908		138552	3/4	2¼"	4-10	0	16.7	200 lb. salt
168880		040293	131930	039227		138650	3/4	2"	4-11	0	12.4	200 lb. salt
169647		040487	132159	039554		138746	3/4	2¼"	4-12	0	16.7	200 lb. salt
170390		040664	132881	039861		138838	3/4	2¼"	4-13	0	16.7	200 lb. salt
171158		040847	132607	040200		138942			4-14	0		200 lb. salt
171823		041011	132790	040510		139039	3/4	2½"	4-15	0	21.7	200 lb. salt
172473		041199	132987	040754		139147	3/4	2-3/4	4-16	0	27.5	
173215		041358	133189	041189		139245	3/4	1-3/4	4-17	0	8.9	Put dust collectors in system
174188		041542	133387	041425		139317	1"	3¼"	4-18	2.2	41.8	200 lb. salt Shut system off, on city water at 11:30 A.M.
175088		041734	133596	041736		139485	3/4	3¼"	4-19	0	41.8	200 lb. salt
175930		041919	133815	042010		139643	3/4	3"	4-20	0	34.2	200 lb. salt
176818		042087	134020	042240		139778	1½"	1¼"	4-21	6.0	3.8	200 lb. salt
178020		042279	134257	042497		139831			4-22			
178998		042437	134434	042725		139893	3/4	3"	4-23	0	34.2	Drained tank 200 lb. salt

TABLE A-2 DAILY METER READINGS 4/3 - 4/23/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
180104		042622	134636	042980		139989	3/4	1"	4-24	0	2.2	200 lb. salt
181200		042812	134858	043213		140055	3/4	1½"	4-25	0	6.0	
182177		042997	135078	043489		140118	3/4	1¼"	4-26	0	3.8	
183067		043178	135299	043737		140203	3/4	1"	4-27	0	2.2	200 lb. salt
184045		043366	135522	044021		140264	3/4	1¼"	4-28	0	3.8	200 lb. salt
184985		043542	135731	044263		140332	1½"	2½"	4-29	6.0	21.7	Purge system 200 lb. salt
186052		043725	135967	044522		140421	1½"	1"	4-30	6.0	2.2	200 lb. salt
186854		043905	136193	044854		140475	3/4	1½"	5-1	0	6.0	200 lb. salt
186854		044084	136380	045185		140537	3/4	1½"	5-2	0	6.0	200 lb. salt
186854		044267	136609	045535		140603	3/4	1"	5-3	0	2.2	200 lb. salt
		044454	136805	045905		140662	3/4	3/4	5-4	0	0	200 lb. salt
		044643	136981	046227		140721	3/4	1¼"	5-5	0	3.8	200 lb. salt
		044620	137139	046551		140779	3/4	1½"	5-6	[illegible]	6.0	200 lb. salt
		045008	137320	046876		140843	1-3/4	2"	5-7	8.9	12.4	300 lb. salt
		045187	137485	047192		140901	1-3/4	2"	5-8	8.9	12.4	200 lb. salt
		045352	137670	047534		140956	1-3/4	2"	5-9	8.9	12.4	200 lb. salt
		045532	137821	047890		141009	1½"	2"	5-10	6.0	12.4	200 lb. salt
		045718	137975	048239		141062	3/4	1"	5-11	0	2.2	200 lb. salt
		045913	138138	048629		141120	3/4	½"	5-12	0	0	200 lb. salt
		046106	138279	048915		141179	1"	3/4	5-13	2.2	0	200 lb. salt
		046286	138433	049293		141241	3/4	1½"	5-14	0	6.0	200 lb. salt
		046447	138576	019597		141293	3/4	1-3/4	5-15	0	8.9	200 lb. salt
		046602	138720	049879		141346	1"	1-3/4	5-16	2.2	8.9	200 lb. salt
		046742	138859			141403	3/4	1½"	5-17	0	6.0	200 lb. salt
		046892	138970			141489	1"	2¼"	5-18	2.2	16.7	Raining 200 lb. salt
		047038	139090			141519	1"	1½"	5-19	2.2	6.0	200 lb. salt

TABLE A-2 DAILY METER READING 4/24 - 5/19/68

DAILY METER READING - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
		047184	139210			141582	3/4	1"	5-20	0	2.2	200 lb. salt
		047333	139343	050149		141626	3/4	½"	5-21	0	0	#5 Meter re-installed in make up line to clean tank
		047466	139482	050361		141671			5-22			200 lb. tank Started chemical feed 200 lb. salt
		047611	139628	050561		141709	3/4	½"	5-23	0	0	200 lb. salt
		047739	139767	050759		141746	3/4	½"	5-24	0	0	200 lb. salt
		047883	139914	050972		141788	3/4	3/4	5-25	0	0	200 lb. salt
		048021	140058	051183		141829	½"	½"	5-26	0	0	200 lb. salt
		048161	140190	051385		141870	1"	1"	5-27	2.2	2.2	200 lb. salt
		048304	140295	051594		141917	1"	1"	5-28	2.2	2.2	200 lb. salt
		048429	140426	051786		141969	1"	1"	5-29	2.2	2.2	200 lb. salt
		048554	140543	051993		142014	1"	3/4	5-30	2.2		200 lb. salt
		048690	140681	052215		142059	1"	1"	5-31	2.2	2.2	200 lb. salt
		048016	140827	052419		142107			6-1			200 lb. salt
		048951	140958	052633		142160	1¼"	1½"	6-2	3.8	6.0	200 lb. salt
		049082	141087	052848		142206	1"	1"	6-3	2.2	2.2	200 lb. salt
		049213	141217	053051		142255	1"	1½"	6-4	2.2	6.0	200 lb. salt
		049347	141349	053247		142302	1¼"	1¼"	6-5	3.8	3.8	200 lb. salt
		049483	141486	053462		142350	1"	1½"	6-6	2.2	6.0	200 lb. salt
		049622	141648	053671		142394	1"	1½"	6-7	2.2	6.0	200 lb. salt
		049768	141789	053887		142436	1"	½"	6-8	2.2	0	200 lb. salt
		049906	141909	054098		142477	1½"	½"	6-9	6.0	0	200 lb. salt

TABLE A-2 DAILY METER READINGS 5/20 - 6/9/69

Appendix A

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
		050036	142024	054309		142522	1"	1½"	6-10	2.2	6.0	200 lb. salt
		050167	142148	054515		142572	½"	1½"	6-11	0	6.0	200 lb. salt
		050296	142284	054720		142631	1½"	1½"	6-12	6.0	6.0	200 lb. salt
		050424	142518	054924		142693	1½"	1-3/4	6-13	6.0	8.9	200 lb. salt
		050568	142709	055226		142745	1½"	1"	6-14	6.0	2.2	200 lb. salt
		050699	142857	055447		142786	1½"	1"	6-15	6.0	2.2	200 lb. salt
		050828	142986	055662		142830	1"	½"	6-16	2.2	0	200 lb. salt
												On hard water 3:00 P.M.
		050937	143095	055843		142867	1½"	1½"	6-17	6.0	6.0	
		051064	143220	056049		142911	1½"	1½"	6-18	6.0	6.0	
		051205	143304	056274		142956			6-19			
		051316	143404	056463		142997			6-20			
		051434	143505	056662		143038	1½"	1"	6-21	6.0	2.2	
		051557	143623	056874		143081	1½"	1"	6-22	6.0	2.2	
		051682	143751	057077		143124	1½"	1"	6-23	6.0	2.2	
		051812	143905	057286		143169			6-24			
		051926	144077	057481		143211	1½"	1½"	6-25	6.0	6.0	
		052034	144233	057688		143262	1"	2"	6-26	2.2	12.4	
		052143	144357	057901		143319	1"	1½"	6-27	2.2	6.0	
		052238	144455	058112		143373	1"	1½"	6-28	2.2	6.0	200 lb. salt
		052354	144537	058333		143415	1"	1½"	6-29	2.2	6.0	
		052455	144630	058537		143465	1"	1½"	6-30	2.2	6.0	
		052564	144730	058751		143511	1"	1½"	7-1	2.2	6.0	
		052673	144837	058956		143558	1"	1½"	7-2	2.2	6.0	
		052797	144969	059182		143609	1"	1-3/4	7-3	2.2	8.9	
		052919	145048	059271		143652	½"	1½"	7-4	0	6.0	
		053061	145129	059363		143696	3/4	1"	7-5	0	2.2	

TABLE A-2 DAILY METER READINGS 6/10 - 7/5/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
		053234	145246	05982		143762			7-6			200 lb. salt
		053341	145351	059712		143801	½"	1½"	7-7	0	6.0	
		053492	145484	059884		143858	1½"	1-3/4	7-8	6.0	8.9	
		053642	145634	060069	583871	143917	3/4	2"	7-9	0	12.4	Back on soft water
187082		053769	145788	060255	586057	143964	1½"	2"	7-10	6.0	12.4	
187926		053906	145915	060473	588073	144019	1½"	2"	7-11	6.0	12.4	200 lb. salt
188907		054045	146042	060690	590467	144061	1½"	2"	7-12	6.0	12.4	
189895		054180	146180	060913	592914	144105	1½"	2"	7-13	6.0	12.4	200 lb. salt
190816		054313	146329	061116	595827	144152	1½"	2"	7-14	6.0	12.4	
191789		054448	146334	061350	598971	144219	1½"	2½"	7-15	6.0	21.7	Back to hard water
192888		054587	146340	061602	602289	144280	1½"	1½"	7-16	6.0	6.0	300 lb. salt
193701		054685	146462	061805	604518	144330	1½"	1½"	7-17	6.0	6.0	
194638		054791	146462	062021	607146	144397	3/4	1-3/4	7-18	0	8.9	
195597		054915	146567	062236	609860	144441	3/4	1"	7-19	0	2.2	200 lb. salt
196498		055026	146801	062935	612431	144482	3/4	1"	7-20	0	2.2	
197437		055138	146907	062638	615094	144537	3/4	1-3/4	7-21	0	8.9	200 lb. salt
198255		055225	147091	062831	617347	144587	1¼"	2"	7-22	3.8	12.4	
199082		055338	147282	063041	619694	144648	1½"	2"	7-23	6.0	12.4	300 lb. salt
199923		055953	147732	063241	622112	144705			7-24			
200795		055593	148078	063472	624311	144765			7-25			200 lb. salt
201647		055720	148394	063680	626454	144824	1"	2"	7-26	2.2	12.4	
202535		055853	148743	063903	628902	144888	3/4	1½"	7-27	0	6.0	200 lb. salt
203375		055977	149083	064110	631302	144941	1"	2"	7-28	2.2	12.4	
204190		056116	149364	064321	633683	144990	1½"	2"	7-29	6.0	12.4	
205094		056250	149682	064539	636160	145042	1"	1½"	7-30	2.2	6.0	
205901		056357	149945	064718	638504	145095	1"	2"	7-31	2.2	12.4	300 lb. salt

TABLE A-2 DAILY METER READINGS 7/6 - 7/31/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
206779		056517	150057	064953	640727	145149	1"	2½"	8-1	2.2	21.7	
207644		056659	150186	065182	042887	145206	1"	2½"	8-2	2.2	21.7	200 lb. salt
208543		056791	150353	065400	645106	145256	½"	2"	8-3	0	12.4	
209523	010697	056929	150530	065592	647515	145312	1"	2"	8-4	2.2	12.4	200 lb. salt
210370		057073	150678	065749	649668	145363	1½"	2½"	8-5	6.0	21.7	
211270		057208	150953	067975	651884	145424	1"	2½"	8-6	2.2	21.7	200 lb. salt
212152		057340	151455	066203	654213	145485	1½"	2"	8-7	6.0	12.4	
213052		057472	151637	066434	656723	145548	2"	2"	8-8	12.4	12.4	300 lb. salt
213885		057602	151849	066633		145590	1"	2½"	8-9	2.2	21.7	Rain
214730		057727	152044	066840	661364	145631	1"	2"	8-10	2.2	21.7	200 lb. salt
215584		057853	152239	067048	663671	145680	1½"	2½"	8-11	6.0	21.7	
216404		057980	152448	067256	665752	145734	1"	2"	8-12	2.2	12.4	200 lb. salt
217170		058135	152593	067495	666662	145788	1"	2½"	8-13	2.2	21.7	
217931		058260	152690	067724		145843	1"	2"	8-14	2.2	12.4	200 lb. salt
218809		058398	152793	067954		145900	1"	2"	8-15	2.2	12.4	
219607		058511	152927	068182		145951	1½"	1½"	8-16	6.0	6.0	300 lb. salt
220372		058693	153076	068417		145996	1½"	1½"	8-17	6.0	6.0	
221579		058833	153177	068624		146048	1-3/4	2"	8-18	8.9	12.4	200 lb. salt
222192		058960	153295	068833		146103	1½"	2"	8-19	6.0	12.4	
223140		059107	153424	069065		146165	1-3/4	2"	8-20	8.9	12.4	200 lb. salt
223998		059228	153525	069252		146209	1½"	2"	8-21	6.0	12.4	
224865		059372	153649	069476		146263	1-3/4	2"	8-22	8.9	12.4	200 lb. salt
225802		059508	153768	069697		146306	1"	1"	8-23	2.2	2.2	
226604		059631	153908	069899		146351	1"	1"	8-24	2.2	2.2	200 lb. salt
No Data									8-25			
228186		059882	154322	070281		146457	1"	1"	8-26	2.2	2.2	200 lb. salt
228977		060027	154603	070501		146518	1-3/4	2"	8-27	8.9	12.4	

TABLE A-2 DAILY METER READINGS 8/1 - 8/27/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
229810		060174	154847	070730		146575	1-3/4	2"	8-28	8.9	12.4	200 lb. salt
230622		060314	154979	070959		146633	1-3/4	2"	8-29	8.9	12.4	
231380		060451	155091	071176		146682	1½"	1-3/4	8-30	6.0	8.9	200 lb. salt
232135		060587	155219	071397		146726	1"	1"	8-31	2.2	2.2	
232940		060719	155360	071609		146781	1"	1"	9-1	2.2	2.2	300 lb. salt
233701		060854	155506	071765		146824	1"	1"	9-2	2.2	2.2	
234737		060983	155816	071923		146878			9-3			200 lb. salt
235661		061118	156001	072127		146929	1-3/4	2"	9-4	8.9	12.4	
No Data									9-5			
237460		061378	156257	072529		147020	1"	2"	9-6	2.2	12.4	200 lb. salt
No Data									9-7			
239298		061693	156526	072950		147108	1"	1"	9-8	2.2	2.2	300 lb. salt
240277		061830	156674	073168		147153	1"	1"	9-9	2.2	2.2	200 lb. salt
241231		061970	156801	073357		147188	1"	½"	9-10	2.2	0	
242191		062110	156934	023555		147229	1½"	1"	9-11	6.0	2.2	200 lb. salt
243118		062251	157058	073766		147275	1½"	2"	9-12	6.0	12.4	
244042		062395	157192	073979		147319	1½"	½"	9-13	6.0	0	200 lb. salt
244945		062536	157328	074186		147356	1½"	3/4	9-14	6.0	0	
245778		062665	157458	074386		147400	1½"	2-3/4	9-15	6.0	27.5	200 lb. salt
246738		062802	157581	074601		147442			9-16			Raining
247698		062953	157722	074815		147487			9-17			200 lb. salt
248750		063109	157848	075045		147526	1½"	¼"	9-18	6.0	0	
249684		063256	157938	075260		147566	1½"	¼"	9-19	6.0	0	200 lb. salt
250657		063406	158039	075504		147606	1½"	¼"	9-20	12.4	0	
									9-21			200 lb. salt
252390		063687	158260	075931		147684	1¼"	1½"	9-22	3.8	6.0	
253332		063828	158318	076140		147730	1½"	2"	9-23	6.0	12.4	200 lb. salt

TABLE A-2 DAILY METER READINGS 8/28 - 9/23/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
254226		063974	158440	076342		147768	3/4	1½"	9-24	0	6.0	
255332		064136	158567	076555		147810	3/4	1¼"	9-25	0	3.8	200 lb. salt
256584		064288	158690	076773		147862	1½"	1½"	9-26	6.0	6.0	
257619		064445	158902	077026		147909	1½"	2"	9-27	6.0	12.4	200 lb. salt
258		064593	159057	077220		147943	1"	¼"	9-28	2.2	0	
259588		064756	159242	077435		147985	1½"	¼"	9-29	6.0	0	200 lb. salt
260621		064901	159402	077629		148021	1½"	1½"	9-30	6.0	6.0	
261448		065040	159577	077782		148086	2"	2½"	10-1	12.4	21.7	Flushed system 200 lb. salt
262506		065180	159757	077966		148129			10-2			
263549		065333	159949	078162		148173	1"	1"	10-3	2.2	2.2	200 lb. salt
264578		065485	160132	078380		148215	1½"	3/4	10-4	6.0	0	
265687		065653	160304	078629		148260	1½"	½"	10-5	6.0	0	200 lb. salt
266839		065798	160488	078841		148301	1½"	2"	10-6	6.0	12.4	
268139		065944	160666	079048		148346	1-3/4	2"	10-7	8.9	12.4	300 lb. salt
269360		066089	160848	079258		148389	1-3/4	2"	10-8	8.9	12.4	A-12/B-10*
270476		066251	161037	079479		148436	2¼"	1½"	10-9	16.7	6.0	A-10/B-12 200 lb. salt
271721		066400	161208	079678		148477	1½"	1½"	10-10	6.0	6.0	A-7/B-12
273001		066562	161393	079898		148522	1½"	1½"	10-11	6.0	6.0	A-12/B-11½
274099		066706	161565	086096		148557	2-3/4	3"	10-12			200 lb. salt A-3½/B-11½ B-2½ Rain

* On Stream Hours - Filter A
Filter B

TABLE A-2 DAILY METER READINGS - 9/24 - 10/12/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
275235		066851	161744	080309		148603	2-3/4	3"	10-13			A-12/B-12 200 lb. salt
276465		066998	161924	080518		148643	1-3/4	1½"	10-14	8.9	6.0	Rain A-12/B-12
277646		067142	162106	080736		148685	1½"	1"	10-15	6.0	2.2	A-12/B-2
278733		067276	162263	080929		148723	1½"	1-3/4	10-16	6.0	8.9	200 lb. salt A-12/A-12 Mechanical seal on "B" Filter Pump failed
279977		067416	162451	081137		148772	1½"	½"	10-17	6.0	0	A-9
281150		067551	162592	081337		148807	1"	½"	10-18	2.2	0	200 lb. salt A-11/A-5 Running on "A" Filter only due to Pump failure "B"
282363		067697	162765	081548		148847			10-19			A-12
283542		067845	162943	081754		148894	2¼"	1-3/4	10-20			200 lb. salt A-12/A-8
284743		067987	163088	081987		148937	1"	1½"	10-21	2.2	6.0	200 lb. salt A-11/A-8
285909		068135	163251	082206		148983	1-3/4	3/4	10-22	0	0	A-12/A-12
287168		068272	163500	082430		149024	3/4	3/4	10-23	0	0	200 lb. salt A-12
288286		068414	163535	082634		149067	3/4	3/4	10-24	0	0	A-10-3/4 A-8/A-12 200 lb. salt

TABLE A-2 DAILY METER READINGS 10/13 - 10/24/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
289436		068551	163683	082855		149108	3/4	3/4	10-25	0	0	A-8½/A-7½
290690		068691	163830	083074		149154	1"	½"	10-26	2.2	0	200 lb. salt A-6/A-8¼ A-7½
291920		068831	163971	083431		149217	1"	½"	10-27	2.2	0	200 lb. salt A-7½/A-4
292639		068965	164102	084087		149339	3/4	3/4	10-28	0	0	On city water 10:00 A.M. Back on filter 12:00 Noon
293508		069105	164264	084289		149382	3/4	3/4	10-29	0	0	200 lb. salt B-12/A-12
294349		069246	164400	084513		149431	3/4	3/4	10-30	0	0	B-12/A-12
295232		069387	164552	084746		149474	3/4	3/4	10-31	0	0	200 lb. salt B-12/A-12
296008		069524	164670	084953		149523	3/4	3/4	11-1	0	0	B-12/A-12
296799		069661	164771	085156		149557	3/4	3/4	11-2	0	0	200 lb. salt B-12/A-12
297632		069803	164906	085374		149604	1"	½"	11-3	2.2	0	B-12/A-12
298498		069923	165031	085565		149645	2"	2"	11-4			300 lb. salt B-12/A-11½ B-7
299388		070071	165178	085791		149692	3/4	1"	11-5	0	2.2	Rain A-12/B-12
300270		070211	165323	085997		149732	3/4	3/4	11-6	0	0	200 lb. salt A-11/B-7½

TABLE A-2 DAILY METER READINGS 10/25 - 11/6

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
301206		070357	165482	086209		149779	3/4	3/4	11-7	0	0	A-12/B-10 200 lb. salt
302104		070499	165627	086380		149809	3/4	3/4	11-8	0	0	A-12/B-12
302894		070644	165743	086584		149850	3/4	3/4	11-9	0	0	A-12/B-12 A-11½ 200 lb. salt
303775		070793	165858	086808		149897	3/4	3/4	11-10	0	0	B-5/A-12
304705		070934	166005	087009		149934	½"	1"	11-11	0	2.2	B-8.5/A-7 B-4/A-5
305679		071081	166147	087209		149978	1"	1-3/8	11-12	2.2	5.0	B-7/A-12 B-8 300 lb. salt
306598		071204	166286	087406		150015	3/4	3/4	11-13	0	0	A-7/B-5 A-4/B-5½ A-4½
307593		071340	166435	087602		150055	3/4	3/4	11-14	0	0	B-6/A-5 B-5½ 200 lb. salt
308607		071474	166578	087801		150096	3/4	3/4	11-15	0	0	A-10½/B-12 200 lb. salt
309684		071616	166728	087998		150130	3/4	3/4	11-16	0	0	A-12/B-12
310718		071768	166864	088213		150173	3/4	3/4	11-17	0	0	A-12/B-12 200 lb. salt
311805		071917	167019	088430		150222	1"	1"	11-18			A-12/B-8 200 lb. salt Rain
312897		072063	167164	088658		150263			11-19			A-12/B-12 Snow

TABLE A-2 DAILY METER READINGS 11/7 - 11/19/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
314067		072214	167285	088858		150303			11-20			A-12/B-10½ 300 lb. salt Snow
315213		072367	167444	089079		150342	3/4	3/4	11-21	0	0	A-12/B-11
316290		072517	167629	089300		150387	3/4	½"	11-22	0	0	A-12/B-9½ 200 lb. salt
317290		072655	167795	089516		150426	3/4	½"	11-23	0	0	A-9½/B-12 A-12 200 lb. salt
318319		072800	168005	089734		150466	3/4	½"	11-24	0	0	B-12/A-12
319278		072936	168186	089930		150507	3/4	½"	11-25	0	0	B-12/A-12 200 lb. salt
320206		073070	168359	090113		150548	3/4	½"	11-26	0	0	B-12/A-12 200 lb. salt
321243		073217	168519	090324		150588	½"	½"	11-27	0	0	B-12/A-12
322251		073363	168687	090531		150631	0	1"	11-28	0	2.2	B-12 300 lb. salt
323343		073514	168855	090742		150669	½"	½"	11-29	0	0	A-12/B-12
324385		073648	169004	090933		150710	3/4	½"	11-30	0	0	A-12/B-12 200 lb. salt
325343		073801	169166	091120		150777	3/4	½"	12-1	0	0	A-12/B-8 A-12 200 lb. salt
326306		073955	169332	091370		150820	3/4	½"	12-2	0	0	B-12/A-12 200 lb. salt
327268		074108	169538	091588		150860	3/4	¼"	12-3	0	0	B-12/A-5

TABLE A-2 DAILY METER READINGS 11/20 - 12/3/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
328347		074242	169718	091797		150904	3/4	¼"	12-4	0	0	B-9½/A-8½ B-12
329343		074394	169900	092000		150941	3/4	¼"	12-5	0	0	200 lb. salt A-12/B-12
330350		074537	170092	092203		150984	3/4	¼"	12-6	0	0	A-12/B-12
331341		074678	170305	092430		151024	1"	½"	12-7	0	0	300 lb. salt A-10½/B-12
332329		074834	170499	092653		151073	3/4	½"	12-8	0	0	Rain A-12/B-12
333507		075014	170710	092913		151123	3/4	¼"	12-9	0	0	200 lb. salt A-12/B-12
334676		075193	170883	093153		151174	3/4	¼"	12-10	0	0	200 lb. salt A-12/B-12
335842		075377	171056	093434		151227	3/4	½"	12-11	0	0	200 lb. salt A-12/B-12
336918		075558	171230	093712		151280	3/4	¼"	12-12	0	0	200 lb. salt A-12/B-12
337968		075739	171383	093988		151325	3/4	¼"	12-13	0	0	200 lb. salt A-8/B-8
339037		075903	171560	094258		151375	3/4	¼"	12-14	0	0	A-12/B-12
340089		076119	171722	094520		151446	3/4	¼"	12-15	0	0	300 lb. salt A-12/B-8½
341186		076269	171920	094892		151439	3/4	¼"	12-16	0	0	200 lb. salt A-12/B-4½
342215		076478	172086	095153		151558	3/4	½"	12-17	0	0	A-12/B-12 200 lb. salt

TABLE A-2 DAILY METER READINGS 12/4 - 12/17/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1969	Weir #1 GPM	Weir #2 GPM	Remarks
343179		076690	172226	095421		151590	3/4	½"	12-18	0	0	A-12/B-12
344294		076852	172387	095685		151642	3/4	¼"	12-19	0	0	200 lb. salt A-12/B-12
345415		077042	172523	095956		151688	3/4	¼"	12-20	0	0	200 lb. salt A-12/B-12
346637		077230	172688	096258		151738	3/4	¼"	12-21	0	0	A-12/B-12
347957		077421	172904	096545		151795	3/4	¼"	12-22	0	0	A-12/B-11½
349276		077591	173089	096797		151849	3/4	½"	12-23	0	0	200 lb. salt A-12/B-12
350610		077781	173252	097067		151896	3/4	½"	12-24	0	0	200 lb. salt A-12/B-12
351875		077975	173416	097380		151950	3/4	¼"	12-25	0	0	A-12/B-12
353089		078175	173599	097646		151998	3/4	½"	12-26	0	0	A-12/B-12
354254		078360	173769	097927		152049	3/4	¼"	12-27	0	0	200 lb. salt A-12/B-12
355546		078557	173932	098206		152101	3/4	¼"	12-28	0	0	200 lb. salt A-12/B-12
356822		078749	174112	098490		152154	3/4	¼"	12-29	0	0	200 lb. salt A-12/B-12
358029		078939	174289	098772		152206	3/4	¼"	12-30	0	0	300 lb. salt A-12/B-12
359169		079126	174448	099048		152252	3/4	¼"	12-31	0	0	200 lb. salt A-12/B-12

TABLE A-2 DAILY METER READINGS 12/18 - 12/31/69

DAILY METER READINGS - WPRD 87-01-68

Meter #2 x 100 gals.	Meter #8 x 10 gals.	Meter #3 x 100 gals.	Meter #4 x 10 gals.	Meter #5 x 100 gals.	Meter #6 x 10 gals.	Main Meter #1 x 100 CF	Weir Box #1	Weir Box #2	Date 1970	Weir #1 GPM	Weir #2 GPM	Remarks
360335		079333	174614	099346		152309	3/4	1/4"	1-1	0	0	A-12/B-12 200# salt
361481		079518	174811	099634		152364	3/4	1/2"	1-2	0	0	A-12/B-12 200# salt
362704		079724	175023	099923		152413	3/4	1/4"	1-3	0	0	A-12/B-12
363892		079914	175192	100197		153458	3/4	1/4"	1-4	0	0	A-12/B-10 200# salt
365106		080105	175365	100480		152517	3/4	1/4"	1-5	0	0	A-12/B-12
366142		080187	175489	100623		152551	3/4	1/4"	1-6	0	0	A-12/B-12 300# salt
367345		080255	175596	100723		152580	3/4	1/4"	1-7	0	0	A-12/B-12 200# salt
368623		080307	175705	100814		152607	3/4	0	1-8	0	0	A-12/B-12 200# salt
369538		080374	175825	100930		152634	3/4	0	1-9	0	0	A-12/B-4½ 200# salt
370431		080441	125966	101040		152656	3/4	0	1-10	0	0	A-12/B-12
371392		080508	176091	101149		152676	3/4	0	1-11	0	0	A-12/B-12 200# salt
372311		080598	176208	101275		152708	3/4	0	1-12	0	0	A-12/B-12
373444		080803	176409	101538		152753	3/4	0	1-13	0	0	A-12/B-12
374398		080943	176561	101771		152807	3/4	0	1-14	0	0	A-12/B-12 300# salt
375655		081153	176741	102002		152857	3/4	0	1-15	0	0	A-12/B-12 200# salt

TABLE A-2 DAILY METER READINGS 1/1 - 1/15/70

TABLE #A3 - Part 1
WATER QUALITY DATA - DISCHARGE

Discharge Data - ppm - 1969

	Sample #1 - Treatment Tank				Sample #2 - Downstream of Discharge			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
3/13	31.3	91	7,890	11.1	2.8	1	922	9.1
3/20	21.2	89	6,799	11.7	.41	24	628	7.9
3/27	13.7	255	7,372	11.7	.09	42	504	8.5
4/3	3.9	202	6,759	12.0	.84	30	617	9.1
4/10	22.6	37	6,800	11.9	.10	22	510	8.5
4/17	8.6	21	5,965	11.7	.28	6	711	7.5
4/24	5.6	61	5,856	11.7	1.3	31	971	8.0
5/1	9.8	20	6,585	11.2	.39	4	619	8.1
5/8	7.2	25	7,740	11.2	.24	23	403	7.7
5/15	6.2	17	4,890	10.5	.81	35	934	8.7
5/22	1.0	19	3,721	11.5	.01	2	656	8.1
5/29	.70	29	8,507	12.1	.02	7	685	7.8
6/5	2.8	42	5,912	11.5	.02	596	958	7.8
6/12	4.2	2	6,383	11.2	.53	13	914	8.1
6/19	5.6	53	7,386	11.6	.21	60	824	8.0
6/26	11.2	66	8,040	12.2	4.2	28	1,430	9.1
7/3	11.2	44	6,912	12.2	.10	0	768	8.0
7/10	22.3	167	11,391	11.9	1.6	10	707	9.2
7/17	10.4	110	5,440	11.6	0	16	491	7.6
7/24	48.7	55	6,659	10.0	.01	110	493	7.9
7/31	No report							
8/7	73.1	62	10,287	11.0	.08	2	538	9.3
8/14	36.5	72	9,593	11.1	.01	3	429	8.8
8/21	No report							
8/28	22.2	58	9,118	11.9	0	6	645	9.0
9/5	40.5	29	8,827	11.5	3.5	88	1,936	9.3
9/11	53.9	28	8,462	11.1	0	0	658	9.0
9/18	30.5	30	8,014	11.9	.02	2	628	9.1
9/26	45.7	28	7,668	10.8	.09	8	624	8.6
10/3	23.8	132	8,258	11.2	1.4	2	632	8.7
10/9	39.2	100	9,880	11.2	4.5	46	804	9.1
10/16	16.8	112	9,392	11.9	11.1	224	1,076	9.3
10/23	28.7	34	8,870	11.7	6.0	244	1,288	9.1
10/30	26.8	756	6,942	11.1	.82	36	804	8.7
11/6	6.8	124	7,336	12.4	.38	154	1,058	9.2
11/13	6.1	8	4,204	11.7	3.1	18	972	8.9
11/20	23.3	10	3,072	10.8	.07	1	564	8.8
11/26	20.0	264	6,188	12.0	1.5	4	904	9.6

TABLE #A3 - Part 2
WATER QUALITY DATA - DISCHARGE

Discharge Data - ppm - 1969

	Sample #1 - Treatment Tank				Sample #2 - Downstream of Discharge			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
12/4	8.7	34	3,644	10.7	1.4	24	702	8.9
12/11	20.9	96	6,442	11.5	.42	4	416	9.2
12/18	17.4	36	7,546	12.3	12.5	24	5,574	12.0
12/24	20.9	360	5,576	11.7	1.4	1,308	2,128	9.1
12/31	15.7	70	6,780	12.0	6.7	92	4,034	11.4

TABLE #A3 - Part 3
WATER QUALITY DATA - DISCHARGE

Discharge Data - ppm - 1969

	Sample #3 - #1 Weir				Sample #4 - #2 Weir			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
3/13	8.0	17	1,294	9.4	.76	57	562	8.4
3/20	1.25	78	860	8.0	.44	88	621	7.9
3/27	4.9	68	951	8.3	.20	107	597	8.2
4/3	1.25	169	1,001	7.6	3.5	75	1,369	9.4
4/10	1.6	88	964	7.7	.25	93	378	9.5
4/17	2.5	10	1,062	7.6	.28	37	559	7.3
4/24	2.4	340	2,204	8.4	4.2	34	1,845	7.7
5/1	.93	12	776	7.8	.71	3	1,066	7.7
5/8	--	--	--	--	.43	1	254	6.7
5/15	.86	20	966	8.7	.28	76	736	8.8
5/22	.02	5	664	7.5	.36	208	1,286	8.7
5/29	.12	12	890	7.6	.0	1	377	7.6
6/5	1.03	8	726	7.5	.37	0	144	7.1
6/12	.61	32	805	7.6	.003	0	398	7.4
6/19	.48	96	1,192	8.4	.03	15	945	7.9
6/26	7.0	94	1,926	8.3	.93	34	1,108	9.1
7/3	2.3	38	1,033	7.2	.17	1	1,135	7.1
7/10	10.4	48	1,026	7.9	.03	39	495	8.8
7/17	.02	24	627	7.0	.01	11	363	8.3
7/24	.03	12	725	7.9	.02	38	450	7.5
7/31	No report							
8/7	.03	14	538	7.8	.33	0	558	8.2
8/14	.08	12	457	7.7	.02	4	353	8.2
8/21	No report							
8/28	.02	18	695	7.5	.01	0	595	7.6
9/5	3.5	62	1,903	9.2	.85	30	684	8.5
9/11	0	0	569	8.0	.02	38	720	8.5
9/18	.01	8	640	8.2	.02	4	280	8.2
9/26	0	0	448	8.1	.02	0	442	8.0
10/3	1.4	0	632	7.8	.56	24	708	8.2
10/9	6.9	126	1,074	8.4	1.5	4	836	9.2
10/16	1.3	0	688	9.4	19.1	50	1,014	8.5
10/23	.02	2	382	8.2	.06	0	380	8.2
10/31	.19	32	796	8.2	.03	0	436	8.7
11/6	.45	70	934	8.2	.02	0	484	8.1
11/13	0	0	496	8.2	.0	1	496	8.0
11/20	.87	0	126	8.2	.14	7	532	8.3
11/26	.28	16	808	8.7	0	0	516	8.3

TABLE #A3 - Part 4
WATER QUALITY DATA - DISCHARGE

Discharge Data - ppm - 1969

	Sample #3 - #1 Weir				Sample #4 - #2 Weir			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
12/4	1.5	20	688	8.6	.05	0	516	8.3
12/11	1.2	16	618	8.2	.38	0	124	8.0
12/18	.05	2	878	9.1	7.3	22	5,188	12.0
12/24	.13	10	788	8.2	.56	0	388	7.4
12/31	5.7	124	4,100	11.3	9.0	16	2,158	9.5

TABLE #A4 - Part 1
WATER QUALITY DATA - RECIRCULATED WATER

System Performance Data - 1969 - ppm

	Sample #5 - Entering Primary Filter West				Sample #6 - Dirty Water Tank			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
3/13	29.6	21	3,989	--	26.1	33	3,692	--
3/20	31.3	105	5,784	--	40.4	65	6,271	--
3/27	47.9	79	6,390	--	53.9	87	7,178	--
4/3	11.7	46	1,832	--	29.6	21	1,944	--
4/10	15.3	58	4,136	--	28.7	77	4,819	--
4/17	11.8	110	4,154	--	20.0	113	3,562	--
4/24	6.1	61	2,077	--	9.4	183	2,740	--
5/1	13.4	131	3,434	--	11.3	60	3,220	--
5/8	7.8	69	3,092	--	5.7	22	2,870	--
5/15	48.7	105	8,057	8.8	10.3	69	3,191	9.3
5/22	14.3	27	3,942	9.2	10.8	35	5,645	9.4
5/29	8.0	2,056	3,405	9.5	10.6	12	3,505	9.3
6/5	15.7	4,126	5,374	9.3	15.8	27	3,952	9.2
6/12	7.4	13,052	15,252	9.2	7.6	64	3,300	9.1
6/19	6.6	3,600	7,608	9.2	4.3	127	2,830	9.2
6/26	5.2	290	3,325	9.5	5.6	53	2,581	9.4
7/3	6.3	29,740	33,818	9.5	8.0	118	3,623	9.3
7/10	16.9	8,180	11,506	9.5	16.9	8,180	11,506	9.5
7/17	6.0	17,772	19,386	9.2	6.4	44	3,397	9.0
7/24	15.0	11,592	14,600	9.5	16.5	126	3,735	9.4
7/31	No report							
8/7	13.6	24,450	29,252	9.6	13.7	81	4,130	9.3
8/14	11.6	4,232	4,348	9.6	11.2	127	3,731	9.3
8/21	No report							
8/28	18.4	560	4,888	9.4	21.9	52	4,628	9.2
9/5	48.7	86	5,768	9.8	2.9	18	5,920	9.6
9/11	17.6	140	4,957	9.7	33.1	55	5,012	9.5
9/18	19.1	12,436	19,144	10.0	20.7	60	4,800	9.9
9/26	32.7	266	5,126	9.6	32.4	104	6,350	9.5
10/3	26.4	80	5,288	9.6	33.4	96	8,104	9.3
10/9	45.2	486	6,406	9.5	43.1	104	6,996	9.4
10/16	14.9	3,340	6,744	9.7	21.3	64	5,038	9.6
10/23	19.3	168	3,800	9.7	15.8	104	4,710	9.4
10/30	20.6	88	3,856	9.5	20.9	8	4,560	9.3
11/6	24.4	5,496	13,104	9.6	23.5	96	5,292	9.6
11/13	17.4	5,416	6,466	9.6	26.9	96	6,500	9.4
11/20	22.2	512	5,104	9.6	17.6	32	5,420	9.5
11/27	19.1	328	5,264	9.8	23.5	136	6,692	9.5

TABLE #A4 - Part 2
WATER QUALITY DATA - RECIRCULATED WATER

System Performance Data - 1969 - ppm

	Sample #5 - Entering Primary Filter West				Sample #6 - Dirty Water Tank			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
12/4	24.4	202	4,580	9.7	27.8	100	6,724	9.5
12/11	29.6	184	6,372	9.3	20.9	98	4,478	9.6
12/18	25.2	220	7,230	9.5	24.4	122	6,228	9.8
12/24	22.4	92	5,016	9.5	30.5	228	4,670	9.5
12/31	20.9	64	5,502	9.4	17.1	424	4,636	9.6

TABLE #A4 - Part 3
WATER QUALITY DATA - RECIRCULATED WATER

System Performance Data - ppm - 1969

	Sample #7 - Entering Clean Water Tank				Sample #8 - Supply Tank After Make-up and Cartridge Filter			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
3/13	--	3	1,751	--	12.2	2	2,060	9.7
3/20	--	18	5,820	--	28.5	15	5,306	9.7
3/27	--	52	6,016	--	22.3	26	4,719	9.7
4/3	--	5	1,498	--	8.5	3	1,018	9.6
4/10	--	4	4,133	--	15.3	3	2,894	9.5
4/17	--	1	3,523	--	12.9	2	2,993	9.7
4/24	--	2	2,128	--	8.0	3	1,563	7.8
5/1	--	1	3,208	--	24.3	2	3,160	9.6
5/8	--	2	2,907	--	3.5	3	2,255	--
5/15	--	1	2,990	9.2	11.1	1	2,331	9.1
5/22	--	1	3,240	9.5	12.5	3	2,344	9.4
5/29	--	0	2,682	9.5	10.2	2	2,456	9.5
6/5	--	7	3,715	9.4	11.5	7	3,215	9.3
6/12	--	0	3,254	9.3	4.2	0	2,535	9.2
6/19	--	2	2,050	9.3	2.4	85	2,090	9.3
6/26	--	15	3,025	9.6	3.7	0	2,400	9.5
7/3	--	0	2,898	9.6	5.7	0	2,529	9.5
7/10	--	4	4,463	9.6	11.2	0	3,216	9.6
7/17	--	3	2,105	9.4	5.0	0	2,562	9.3
7/24	--	53	3,473	9.6	11.0	0	2,932	9.6
8/7	--	0	3,262	9.6	8.4	0	2,638	9.5
8/14	--	0	3,073	9.6	8.2	0	2,128	9.6
8/21	No report							
8/28	--	0	3,813	9.5	12.7	0	2,622	9.5
9/5	--	0	6,203	9.8	46.9	0	4,494	9.8
9/11	--	0	3,827	9.7	9.1	0	3,574	9.7
9/18	--	8	4,706	10.1	12.8	0	3,760	10.1
9/26	--	4	4,570	9.7	25.1	0	4,592	9.7
10/3	--	0	5,372	9.6	17.7	0	4,392	9.6
10/9	--	4	6,280	9.6	38.3	0	5,268	9.6
10/16	--	32	4,528	9.7	8.7	3	3,850	9.7
10/23	--	7	3,762	9.7	10.3	0	3,058	9.7
10/30	--	6	4,150	9.5	14.8	0	2,976	9.5
11/6	--	8	5,286	9.7	19.1	1	4,222	9.7
11/13	--	5	4,472	9.7	20.9	0	4,086	9.7
11/20	--	2	4,684	9.7	14.3	0	3,760	9.7
11/26	--	12	5,404	9.8	14.8	1	4,520	9.8

TABLE #A4 - Part 4
WATER QUALITY DATA - RECIRCULATED WATER

System Performance Data - ppm - 1969

	Sample #7 - Entering Clear Water Tank				Sample #8 - Supply Tank After Make-up and Cartridge Filter			
Date	Phenol	Susp. Solids	Total Solids	pH	Phenol	Susp. Solids	Total Solids	pH
12/4	--	3	4,876	9.8	20.0	8	4,172	9.8
12/11	--	6	4,428	9.7	19.1	0	3,492	9.7
12/18	--	3	5,852	9.8	18.7	25	4,094	9.8
12/24	--	13	4.164	9.6	20.0	2	3,768	9.6
12/31	--	10	4,632	9.7	11.3	0	3,344	9.7

TABLE #A5
MONTHLY AVERAGE OF DAILY DISCHARGE FLOWS - GALLONS/MIN.

	Weir #1	Weir #2	Total
8/12/68-8/31/68 - 19 days	38.0	2.2	40.2
9/1/68-9/27/68 - 26 days	43.7	6.5	50.2
9/28/68-10/25/68 - 28 days	26.2	2.2	28.4
10/25/68-11/22/68 - 28 days	24.0	.3	24.3
11/22/68-12/20/68 - 28 days	24.8	.0	24.8
12/20/68-1/17/69 - 25 days	14.1	11.8	25.9
1/17/69-2/14/69 - 28 days	2.8	1.3	4.1
2/14/69-3/14/-9 - 28 days	0.0	5.5	5.5 *
3/14/69-4/18/69 - 35 days	1.2	12.1	13.3
4/18/69-5/23/69 - 35 days	1.8	9.1	10.9
5/23/69-7/1/69 - 38 days	3.4	4.2	7.6
7/1/69-7/31/69 - 31 days	2.8	8.6	11.4
7/31/69-8/31/69 - 31 days	4.7	11.6	16.3
8/31/69-9/30/69 - 30 days	4.7	5.4	10.1
9/30/69-10/31/69 - 31 days	4.4	3.9	8.3
10/31/69-11/30/69 - 30 days	.17	.45	.6

* Closed system inoperative 3/6-3/11/69 due to septa failure Diatomite Filter "B".

ADDED OPERATIONAL COSTS AND SAVINGS -vs- BASE PERIOD JULY THROUGH DECEMBER, 1968

Month 1969	(#12) January	(#13) February	(#14) March	(#15) April	(#16) May	(#17) June	(#18) July
Binder Solids	- $1,433	- $1,806	- $1,936	- $3,921	- $4,096	- $4,782	- $3,028
Water	- 326	- 738	- 382	- 311	- 615	- 543	- 431
Solvay Cleaner	- 111	- 111	- 111	- 110	- 110	- 96	- 97
Salt	+ 30	+ 22	+ 25	+ 12	+ 31	+ 5	- 6
Diatomaceous Earth	+ 197	+ 220	+ 241	+ 235	+ 244	+ 238	+ 243
Aqua Ammonia	+ 154	+ 122	+ 128	+ 264	+ 236	+ 124	+ 42
E & R Labor	+ 1,069	+ 1,194	+ 1,318	+ 1,276	+ 1,418	+ 988	+ 1,022
Fiber Glass Filter Tubes	+ 35	+ 29	+ 28	+ 29	+ 29	+ 29	+ 44
Polypropylene Media	+ 32	+ 34	+ 39	+ 38	+ 102	+ 29	+ 150
Fungicide						+ 75	+ 74
Dispersant						+ 121	+ 121
*** Power	+ 200	+ 400	+ 400	+ 400	+ 400	+ 400	+ 400
	- 153	- 634	- 250	- 2,088	- 2,361	- 3,412	- 1,465
Cumulative Savings	- $ 153	- $ 787	- $1,037	- $3,125	- $5,486	- $8,898	-$10,364

+ Represents added costs over base period
- Represents savings over base period
***Power costs are estimated

TABLE 2 - Part 1

TABLE 2 - Part 1

ADDED OPERATIONAL COSTS AND SAVINGS -vs- BASE PERIOD JULY THROUGH DECEMBER, 1968

Month 1969	(#19) August	(#20) September	(#21) October	(#22) November	(#23) December	(#24) January 1970*
Binder Solids	+ $ 731	- $ 619	- $1,489	- $1,988	- $2,679	- $1,984
Water	- 502	- 619	- 598	- 631	- 790	- 621
Solvay Cleaner	- 100	- 99	- 102	- 98	- 123	- 101
Salt	- 1	- 1	- 1	+ 7	+ 4	+ 10
Diatomaceous Earth	+ 244	+ 236	+ 244	+ 271	+ 245	+ 245
Aqua Ammonia	+ 103	+ 162	+ 261	+ 261	+ 313	+ 182
E & R Labor	+ 790	+ 782	+ 1,079	+ 1,033	+ 968	+ 1,058
Fiber Glass Filter Tubes	+ 38	+ 37	+ 39	+ 37	+ 47	+ 38
Polypropylene Media	+ 217	+ 153	+ 95	+ 212	+ 190	
Fungicide	+ 73	+ 109	+ 120	+ 342)	+ 304)	+ 351)
Dispersant	+ 122	+ 189	+ 122	)	)	)
*** Power	+ 400	+ 400	+ 400	+ 400	+ 400	+ 266
	+ 2,115	+ 730	+ 170	- 154	- 1,121	- 556
Cumulative Savings	- $8,249	- $7,519	- $7,349	- $7,503	- $8,624	- $9,180

*Note 1 Grant period ended 1/15/70

Note 2 Gas curtailment eliminated production
Jan. 6-12 - 6 days
Jan. 21-23 - 2 days

+ Represents added costs over base period
- Represents savings over base period
***Power costs are estimated

TABLE 2 - Part 2

TABLE 2 - Part 2

BIBLIOGRAPHIC:

Johns-Manville Products Corporation, Phenolic Waste Reuse by Diatomite Filtration, Final Report FWQA Grant No. 87-01-68, September 1970.

ABSTRACT:

The fiber glass industry has long had a problem in disposing of waste water containing phenolic resins. In the fiber glass manufacturing process, airborne glass fibers are sprayed with a phenolic resin as the fiber blanket is formed on the collecting conveyor causing a deposit of resin to form on the collecting conveyor chain. Prompt cleaning before the deposit sets is needed to permit continuous formation of the glass fiber mat. The waste originates from the chain washing operation which uses either a caustic wash or high volume showers to remove the resin deposits.

Under the demonstration project a chain-cleaning-water-reuse system was installed which consists of low volume, high pressure

ACCESSION NO.

KEY WORDS:

Fiber glass

Phenols

Resin

Diatomaceous Earth Filters

Water Reuse

Operating Cost

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Water Reuse

Operating Cost

1 *Accession Number*

2 *Subject Field & Group*

05D

SELECTED WATER RESOURCES ABSTRACTS
INPUT TRANSACTION FORM

5 *Organization*

Johns-Manville Products Corporation
P.O. Box 159
Manville, New Jersey 08835

6 *Title*

Phenolic Waste Reuse by Diatomite Filtration

10 *Author(s)*

E. I. Merrill

16 *Project Designation*

FWQA Project 12080 EZF

21 *Note*

22 *Citation*

23 *Descriptors (Starred First)*

Fiber Glass
Phenols
Resin
Diatomaceous Earth Filters
Water Reuse
Operating Cost

25 *Identifiers (Starred First)*

27 *Abstract*

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Under the demonstration project a chain-cleaning-waste-reuse system was installed which consists of low volume, high pressure chain cleaning units with water consumption of 8 gallons per minute at a thousand psi, two stages of primary filtration to remove large particles and fiber, and a secondary diatomite filter to remove fine particulate matter. The filtered water is suitable for reuse in the binder batch, overspray system, and the chain cleaning units.

The water reuse system has reduced the quanity of water required for chain cleaning, will use water 4-½ times before evaporation removes it from the system, requires 1 lb. of diatomite per 500 gallons of resin-bearing water filtered and provides water at a net cost of $.37 per 1000 gallons vs $.75 for City water.

This report was submitted in fulfillment of a R&D Grant 12080 EZF between the FWQA and the Johns-Manville Products Corporation.

Abstractor E. I. Merrill

Institution Johns-Manville products Corporation

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